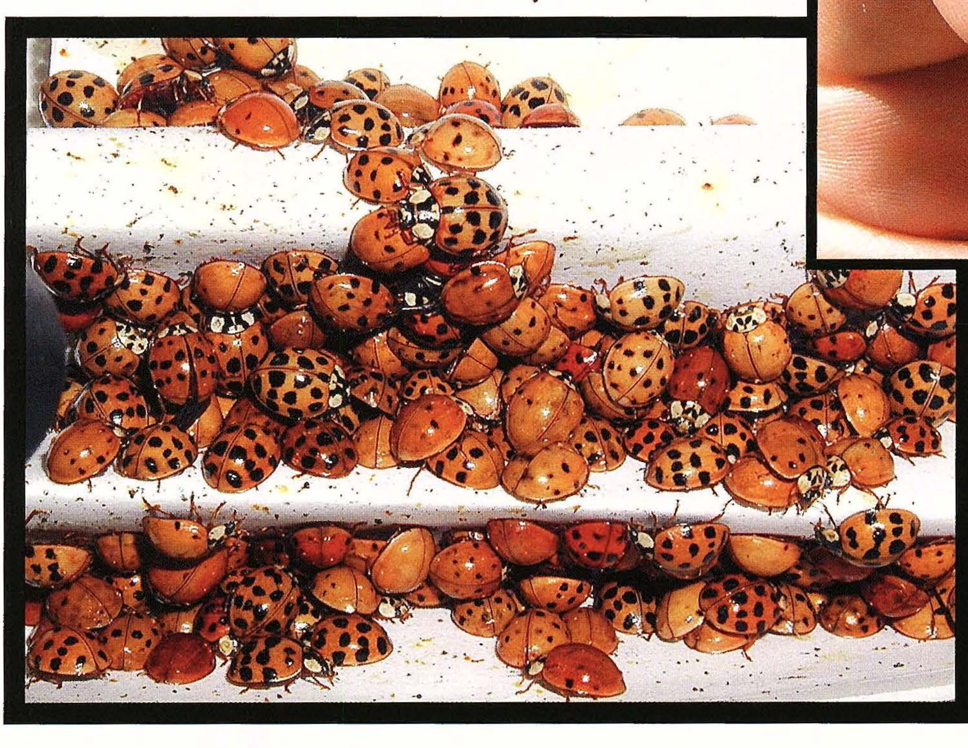
Ornamental Plants

Annual Reports and Research Reviews
2001



January 2002

Special Circular 186

Ohio Agricultural Research and Development Center

In Partnership With Ohio State University Extension

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Director

Ohio Agricultural Research and Development Center
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Ornamental Plants
Annual Reports and Research Reviews
2001

Edited By

James A. Chatfield
Joseph F. Boggs
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Amy K. Stone

Ohio Agricultural Research and Development Center
Ohio State University Extension
Department of Horticulture and Crop Science
The Ohio State University

January 2002
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Cover Photo:

The multicolored Asian lady beetle, *Harmonia axyridis* (Pallas), commonly seeks winter shelter inside homes where they gather in large clusters, such as the one shown on the cover. This behavior makes them a serious nuisance pest. The beetle is a non-native predator of insects and was introduced into the United States in the late 1970s and early 80s to control tree pests. The multicolored Asian lady beetle is currently found throughout Ohio.

Salaries and research support were provided by state and federal funds appropriated to the Ohio Agricultural Research and Development Center and Ohio State University Extension of The Ohio State University's College of Food, Agricultural, and Environmental Sciences. Additional grant support was provided by the organizations and companies listed in the individual research and Extension reports.

Contents

Ohio State University Extension Nursery, Landscape, and Turf Team Directory: 2002

Our Vision

The vision of the Extension Nursery, Landscape, and Turf Team is to serve as the University's partner with the green industry to position us for the future.

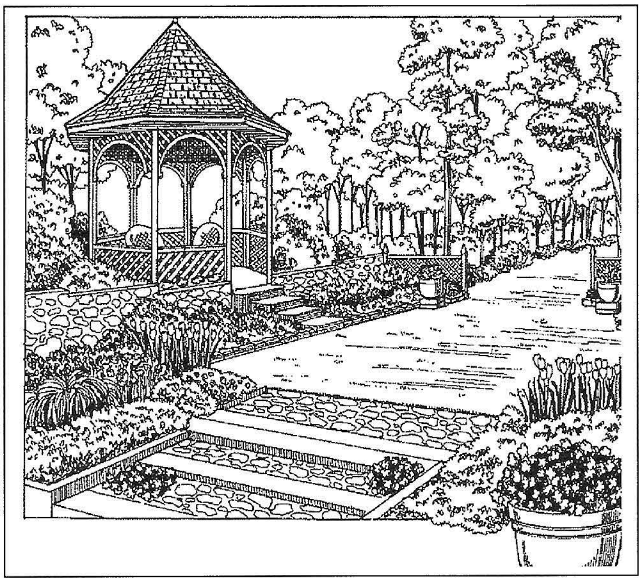
Our Mission

The mission of the Extension Nursery, Landscape, and Turf Team, through our interdisciplinary and industry partnerships, is to improve the process of acquisition, delivery, and support of accurate, practical, and timely educational resources.

An Invitation

Membership on the team is based on interest and commitment to the vision and the mission of the team. Potential members are encouraged to participate in some of our activities to determine if they would like to become a part of our team. If you are interested in the work of the team, please contact any of the team members.

Directory developed by Jack Kerrigan, Ohio State University Extension, Cuyahoga County.



Team Members

Charles Behnke

- Diagnosis of cultural problems of trees and shrubs
- Weed identification
- Insect identification
- Greenhouse management
- Garden center employee training
- IPM

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- Landscape maintenance
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- Turf management
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- Urban forestry
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- Ecology of multi-party systems

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- Diagnosis of plant problems
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- Landscape management
- Nursery operations and management
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- IPM
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- Tree fruits and small fruit management

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- Garden center employee training
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- Host plant resistance
- Monitoring tools for insect pests
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- Nematodes
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- Spray drift
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- Production
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- Cold hardiness research
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- Buckeye column

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- Turfgrass entomology
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- Ornamental woody and herbaceous plant identification

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- Consumer and environmental horticulture
- Green industry training
- Landscape maintenance practices
- Master Gardener Program
- Gypsy moth education

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- Turfgrass management
- Turfgrass fertilization
- Turfgrass weed control
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- Seed propagation
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- Plant establishment

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- Fruit production

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During the growing season, the team teleconferences weekly and develops a newsletter called the *Buckeye Yard and Garden Line,* which is available by a fax subscription service (contact a local team member) or on the World-Wide Web at:

http://www.hcs.ohio-state.edu/hcs/hcs.html

(Ohio State University Department of Horticulture and Crop Science, *Horticulture and Crop Science in Virtual Perspective)*

***Buckeye Yard and Garden Line* Fax Centers**

Clark County	Pam Bennett
Clermont County	Gary Gao
Cuyahoga County	Jack Kerrigan
Franklin County	Jane Martin
Hamilton County	Joe Boggs
Lake County	Randy Zondag
Lucas County	Amy Stone
Montgomery County	Pete Lane
Putnam County	Glen Arnold

Floriculture Industry Roundtable of Ohio: 2002

Our Mission

The mission of the Floriculture Industry Roundtable of Ohio is to provide an educational forum to Extension, growers, and allied industries across the Midwestern region, currently including Ohio, Michigan, Pennsylvania, Kentucky, and Indiana, for the exchange, discussion, and dissemination of information related to floriculture.

Roundtable Resources and Team Members

Greenhouse Management

Barrett, Eric
Behnke, Charles
Brugger, Mike
Dyke, David
Everett, Craig
Gao, Gary
Kneen, Hal
Krauskopf, Dean
McMahon, Peg
Moll, Norm
Pasian, Claudio

Plant Pathology

Ellsworth, Denise
Hoitink, Harry
Nameth, Steve
Taylor, Nancy

Plant Physiology

Jones, Michelle L.

Entomology

Cloyd, Raymond
Steele, Julie

Food, Agricultural, and Biological Engineering/Greenhouse Environment

Ling, Peter
Short, Ted

Management and Economics

Kneen, Hal
Rhodus, Tim

Composting

Hoitink, Harry

Crop Physiology

Carver, Steve
McMahon, Peg
Metzger, James
Pasian, Claudio

Directory developed by Charles Behnke, Ohio State University Extension, Lorain County.

Nutrient Analysis/Water Quality

Carver, Steve
Krauskopf, Dean
Pasian, Claudio
Watson, Maurice

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- Greenhouse management
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- Greenhouse structures
- Engineering

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- Production/postproduction physiology
- Plant nutrition
- Greenhouse management

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- Use of biological controls
- Testing of new products

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- Composting
- Potting mixes/container media formulation
- Biocontrol of plant diseases

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- Small business management
- Production economics
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- Greenhouse crop nutrition
- Foliar and media analysis
- Greenhouse crop management
- Greenhouse rose production

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- Digital image applications

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- Light quality regulation of crop development
- Greenhouse management
- Production of floriculture crops

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- Role of hormones in plant growth and development
- Environmental control of flowering
- Use of biotechnology to improve floricultural crops

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- Diseases of floral crops: identification, control, and management
- Identification and characterization of viruses of floral crops

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- Crop eco-physiology
- Production and management
- Modeling and timing of floricultural crops

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- Management and economics of horticultural crops
- Multimedia applications for marketing and education

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- Greenhouse system design for optimum production
- Evapotranspiration of greenhouse crops
- Solar energy systems
- Mechanization of horticultural crops

Taylor, Nancy

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- Water quality, composting, and environmental pollution problems

Ohio State University Extension's *Buckeye Yard and Garden Line* Evaluation Survey: 2001

Amy K. Stone

I was in the Netherlands for an International Extension Conference this past year. I was introduced to a European colleague as being from Ohio State University. His first response: Ohio State, ah yes, you are the people with Web Garden and the Buckeye Yard and Garden Line....

— Dr. Barbara Ludwig
Chair, OSU Department of Extension

Summary

The *Buckeye Yard and Garden Line (BYGL)* is one of the key ways through which Ohio State University Extension and the Extension Nursery Landscape and Turf Team (ENLTT) provide ornamental plant and plant problem information to the green industry, Extension offices, and the general public.

This article answers some questions about *BYGL* and provides the results of the 2001 *BYGL* Evaluation Survey.

What Is *BYGL?*

The *Buckeye Yard and Garden Line (BYGL)* is a weekly update, created from conference call discussions, in the form of an electronic newsletter. It is written by Ohio State University Extension agents and specialists, every Tuesday from April–October.

BYGL is funded by the Ohio Nursery and Landscape Association (ONLA) and OSU Extension, with additional contributions from the Ohio Chapter of the International Society of Arboriculture (ISA).

Who Is *BYGL's* Audience?

BYGL is written for green-industry professionals, Extension agents, Master Gardener volunteers, consumers, and other horticulturists in Ohio and throughout the United States.

How Do You Receive *BYGL?*

There are three ways to receive *BYGL* — by e-mail, by fax subscription, and by going directly on the World Wide Web. Here's how:

- By e-mail:

  Simply send your e-mail address to Cheryl Fischnich:

  fischnich.1@osu.edu

Amy K. Stone, Ohio State University Extension, Lucas County

- On the World Wide Web:

  Access *Buckeye Yard and Garden onLine* on Ohio State University's *Horticulture and Crop Science in Virtual Perspective*

  http://bygl.osu.edu

- For fax newsletter subscriptions, contact one of these Ohio State University Extension offices:

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Jack Kerrigan 216-397-6000

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Lucas County
Amy Stone 419-578-6783

Montgomery County
Pete Lane 937-224-9654

Putnam County
Glen Arnold 419-523-6294

Is There a Cost for *BYGL?*

There is a fax subscription fee of $40 a year to cover phone-line costs.

If you are a member of the Ohio Nursery and Landscape Association, the Ohio Chapter of the International Society of Arboriculture, or the Ohio Turfgrass Foundation, this fee is waived as part of your membership benefits.

Where Can You Find the Time for *BYGL?*

Reading time during the growing season comes at a premium, and that is why BYGL is formatted in short bytes — one to two paragraphs — of the most relevant information on a particular topic. The authors also strive for a lively, user-friendly, and sometimes humorous style.

What Is *Buckeye Yard and Garden onLine?*

This is the web version of *BYGL*, and it comes not only with the text of *BYGL* available on the e-mail and fax versions, but also with hot links to color images of pests and plants and to more than 23,000 additional fact sheets from Ohio State University and other universities.

What Is *BYGLive!?*

BYGLive! is a series of informal programs held at arboreta throughout Ohio on typically the first Monday of each month.

The participants have a chance to see plants and plant and pest development throughout the season at the sites listed here, to do some diagnostic troubleshooting, and to provide observations and insights that will add to the next day's BYGL conference call.

Sites for 2002, with key contacts, are:

- Cincinnati at Spring Grove Cemetery and Arboretum
  (year-round)
  Joe Boggs
  513-946-8989
- Toledo at Stranahan Arboretum and Toledo Botanical Garden
  (May - October)
  Amy Stone
  419-578-6783
- Akron at Seiberling Naturealm
  (year-round)
  Denise Ellsworth
  330-497-1611

Survey Results

Total Number of Returns: 197

I. General Background Questions

A. What is your primary type of business, operation, or profession?

Number of Commercial or For-Profit Companies: 100

(nursery, landscape, golf course, lawn-care service, tree care/arborist, garden center, industrial or office park/plant, landscape architect/design, and supplier/dealer)

Number of Non-Profit Companies: 90

(Extension, home gardeners/Master Gardeners, park, school, college or university, museum,cemetery/memorial garden, government facility)

B. Are you a member of the following (please select all that apply):

Ohio Nursery and Landscape Association: 78

International Society of Arboriculture: 33

Ohio Turfgrass Foundation: 27

Ohio Florists Association: 18

C. How many people have access to *BYGL* information through your subscription (*i.e.:* employees, customers, students, radio listeners, newspaper readers, newsletter subscribers, Master Gardeners)?

more than 500,000

II. *BYGL* Impact and Usefulness

How strongly do you agree with each of the following statements? Please write down the most appropriate response.

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree
SD = Strongly Disagree
NA = Not Applicable

A. *BYGL* was useful to my job and business:

SA = 108
A = 63
N = 0
D = 0
SD = 0
NA = 7

B *BYGL* helped in answering client/customer questions:

SA = 107
A = 77
N = 3
D = 1
SD = 0
NA = 11

C. I (we) changed some horticultural practices based on information in *BYGL.*

SA = 35
A = 99
N = 44
D = 7
SD = 8
NA = 11

D. I (we) changed some pest management practices based on information in *BYGL.*

SA = 39
A = 100
N = 40
D = 6
SD = 0
NA = 11

E. *BYGL* has resulted in improved customer service in our company or business.

SA = 65
A = 91
N = 14
D = 0
SD = 1
NA = 25

F. What have you learned from *BYGL* this season?

# of new insects learned = 561
# of new diseases learned = 485
# of new cultural (non-insect, non-disease problems learned) = 482
# of times pesticide use was improved = 440

G. Has the information in BYGL saved your company money or increased your net profit?

Yes = 85

H. If you answered *Yes* to Question 6, please check all that apply. This information will only be used for reporting the economic impacts of *BYGL.*

Time savings to you and your operation = 63
Reduction of pesticide usage = 50
Proper selection of plant material = 32
Proper selection of pesticides = 58
Improved customer service = 64

I. If you answered *Yes* to the previous questions, please select a range. This information will only be used for reporting the economic impacts of *BYGL.*

$1 - 500 = 25
$501 - 1,000 = 15
$1,001 - 5,000 = 18
$5,001 - 10,000 = 6
$10,000 or higher = 4

Estimated Total Savings
for Respondents = *$167,500

* This amount understates the economic impact and does not show the total savings of all *BYGL* users, but rather those who completed this year's survey.

Comments

This is your opportunity to make recommendations or suggestions to the people who write *BYGL!* Some of this year s comments included:

BYGL is the best source for timely information. We appreciate the good work. Keep it up.

— Bob Arnold
Berns Garden Center

BYGL lets us know what's current. When clientele come in, they are impressed [that] we know so much. BYGL makes us look good, because we know what's happening across the state, and we can more easily identify their problem and give better advice.

— David Jones
Ohio State University Extension,
Allen County

BYGL is informative and timely. An excellent resource for any landscape contractor.

— Joe Drake
JFD Landscape

Another year of kudos for the BYGL gang!

As mentioned above, we would like to include BYGL as a link on our pending web site, as well as a tag line in our customer newsletter.

— Greg Johnson
Earth Turf

My summers wouldn't be the same without my coffee and BYGL. Don't go away.

— Alan Siewert
Urban Forester

Format is user-friendly, enticing to review, and content rich. You all are the most entertaining and educational folks around. You fill a niche that is needed, that often is very dry and boring and technical publications. Think you have the pulse of readership.

— Dan Studebaker
Studebaker Nurseries

As an Ag Agent, BYGL has helped me better serve my urban clientele with consumer horticulture concerns. It's like having a scouting service in surrounding counties that keeps me forewarned of potential future or current problems in my county.

— Clark Hutson
Ohio State University Extension
Seneca County

We continue to use BYGL to educate our team. Knowledge builds confidence; confidence builds sales. Keep up the good work.

— Jeff Webeler
White Oak Garden Center

As a city arborist, residents often call with questions regarding insects and diseases; the information in BYGL has been very helpful in answering those questions. Thank you very much.

— Gerald Shaney

BYGL is a breath of fresh air. I share with my team, my office staff, and clients, and over 200,000 Listeners to my radio show. For many of us who truly practice IPM, it's our life blood of information. Without it, we can't practice what we believe.

— Mark Webber
Mark Webber's Landscape Co.

Absolutely one of the best sources of timely information we have! Our professionalism and expertise continue to increase, thanks to BYGL. Keep up the good work!

— Ron Wilson
Natorp's Inc.

What a great way to keep on top of all the scientific information and experiences. As a 1977 graduate of Ohio State in turf management, I'm still learning thanks to your newsletter.

— Glen Gentile
Silver Crest Farms

BYGL & Shetlar's Bug Dope are the two publications we provide to our field inspectors. You help them stay alert to what pests are making their appearances during the year and keep them abreast of pests. Your daily rust situation this past summer was exemplary.

— Tom Harrison
Ohio Department of Agriculture

TeamWorks: OSU Extension's Nursery, Landscape, and Turf Team

James A. Chatfield, Joseph F. Boggs, Gary Y. Gao, Erik A. Draper, Keith L. Smith, Barbara G. Ludwig, and Stephen R. Baertsche

The OSU Extension Nursery Landscape and Turf Team (ENLTT) is an example of a collegial interdisciplinary team that works at Ohio State University Extension (OSUE). In looking at what makes it work, our group has identified eight key characteristics of our team (teamisms) that have value in discussing teamwork in general.

[See a full listing of the ENLTT members and the many additional persons who contributed through their activities to the core of this article on page 5 in this publication.]

No. 1: Teams Do Not Form in a Vacuum

Team history and a team's defining moments are important in understanding team development. The ENLTT formed in 1992, during a period of budgetary challenge within the Ohio State University (OSU) College of Agriculture and Ohio State University Extension (OSUE). For example, due to decreased statewide funding at that time, the number of faculty in the horticulture department fell from 30 to 21. This included an early retirement by a key Extension specialist in landscape horticulture. This resulted in the then chairperson of the department calling a meeting of industry clientele; field faculty in Extension; and research, teaching, and field faculty in the horticulture, agronomy, entomology, and plant pathology departments to discuss how to address resource challenges.

In that meeting, several key statements were made. The first was that with the retirement of the landscape horticulture specialist, the "Extension landscape/nursery program" was gone. This statement hung in the room for several beats. It was a not unusual sentiment with regards to a key retirement, but it sounded so wrong.

We all looked around the room, and finally someone spoke up that this was not exactly true. After all, there were numerous Extension agents in the room who had horticulture as their specialty area. There were landscape horticulturists with teaching and research positions in the horticulture department; there were entomologists and plant pathologists and turfgrass agronomists from other departments in the room. In fact, a group of at least 20 people easily came to mind as part of an "Extension landscape/nursery program" at Ohio State.

James A. Chatfield, Ohio State University Extension, Northeast District/Horticulture and Crop Science; Joseph F. Boggs, Ohio State University Extension, Hamilton County/Southwest District; Gary Y. Gao, Ohio State University Extension, Clermont County; Erik A. Draper, Ohio State University Extension, Geauga County; Keith L. Smith, Ohio State University Extension, Director, Associate Vice President, and Associate Dean; Barbara G. Ludwig, Ohio State University Extension, Chair and Associate Director; and Stephen R. Baertsche Ohio State University Extension, Assistant Director.

With that, someone spoke up and asked industry representatives if they would support a transformation of the program. Instead of 20 talented, competent people who loosely knew what each other was doing in the landscape horticulture program, what if we re-organized as a team of 20 talented, competent people who communicated well enough to additionally harness the genius of a team, to seriously run with the ideas of agent specialization and interdisciplinary cooperation? Brian Decker, then president of ONA (now ONLA, the Ohio Nursery and Landscape Association), said that if we developed such a team, "We would not be able to get to the bank fast enough to cash the check."

Talk about defining moments! The rest is history.

From this hook, a team jelled over the next month, coming up with a clear proposal to the industry, asking for financial support for team-building — not simply for money to hire a new person or to provide a new service — but for new money to encourage development of the team. More on that later, but the important lesson is that our team did not arise from simply saying that teamwork is good or necessary, but from a history that includes several defining moments, including a budgetary challenge and a critical interchange with our stakeholders.

No. 2: Teamwork Is Not a Zero-Sum Game

There are two questions that inevitably occur when a person considers becoming a member of a team. These are: How much time will be devoted to team activities? What will a team member give up in order to work on team projects?

This relates to the zero-sum idea that team activities will simply replace activities that were previously done individually and that teams will simply make life even more busy, complicated, and stressful.

This means that a team must be able to define how the team will make each person's job more fruitful and successful. A team must be able to show its members how "teamwork is its own reward."

In our case, the *Buckeye Yard and Garden Line (BYGL)* is an example of how we buttressed the altruistic impulses toward teamwork with the energy of synergy that teamwork provides. *BYGL* (Chatfield, *et al.*, 1996) was started in 1993 as a weekly electronic newsletter for our team. Each week from April-October, team members from around the state meet by conference phone each Tuesday morning, discussing landscape and garden plant problems from their area.

A group of BYGL Writers then convenes on the conference call to decide which items should be written up that week. Over the next two days each writer completes his or her assigned items, and rotating *BYGL* senders and proofers construct, proof, and send out the overall *BYGL* in its fax, e-mail, and web (enhanced by over 20,000 fact sheet and 3,000 image links) versions.

The finished *BYGL* is a timely, professional newsletter that comes out every week and is used by diverse sources, including other Extension offices in Ohio and elsewhere, green industry and other horticultural professionals, Master Gardener Volunteers, consumers, and the media. The newsletter provides the wealth of the Ohio State University expertise emanating as an electronic newsletter from each OSU Extension office.

An important internal benefit of the *BYGL* is that contributors directly benefit from a weekly 90-minute interdisciplinary in-service, complete with clarifications, point counterpointing (Boggs and Chatfield, 1995), and the educational benefit of translating the spoken word into written information — a highly important skill to be regularly honed by Extension professionals. It was once posed that we should try to imagine a world in which we are not truly sure of what we think until we have to write about it — and that this is precisely the world in which we live.

The bottom line for Extension educators is as follows: Each *BYGL* contributor puts in an average of perhaps four hours a week on the *BYGL*. What do they get back? The most timely, useful, and heralded newsletter any of us have ever developed, available to a diverse clientele in every county. [See page 18 in this Special Circular for the 2001 *BYGL* evaluations; Stone, 2002.] Plus we benefit from a weekly 90-minute interactive, interdisciplinary inservice each week during the growing season. What do we have to give up to spend time on team activities? *BYGL* benefits make the question moot.

No. 3: Money Is Not the Root of All Evil

We all know that money is only one type of resource, that teams fundamentally rise and fall on their human resources. We also all know how targeted money can sometimes drive a program in ways that interfere with a more open prioritization of activities. An example is with certain grants in which dollars flow in attached only to one particular static project that will not allow for needed re-prioritizations on the basis of changing circumstances.

With our team, we identified early on that we wanted to develop a new relationship with our industry partners (the Ohio Nursery and Landscape Association and others) that included a yearly proposal and yearly funding and accountability. An early question that arose from these discussions was whether this was just a one-shot deal or whether we would continue to make proposals and seek this funding commitment if our budgetary crisis ended. We quickly focused on the proposal, the partnership, the commitment, and the idea of team-building by being very clear that this was not a short-term relationship we sought, but rather the beginning of a new way of doing business.

With that clear, early understanding and with yearly proposals and accounting with our industry partners, we have secured funding from these organizations totaling more than $250,000 over the past nine years. What is this money for? It is essentially for team-building — to make our team better able to deliver information and programming. It is used to make reference purchases for use by team members for Extension teaching. It is used for laptop computers to facilitate rapid development of the BYGL each week. It is used for cameras to take images used for the *Buckeye Yard and Garden onLine* website.

It is used for pilot projects such as a Plant Health Care program and Information Stations at garden centers. It is used to help defray costs for agents throughout the state to send "agent information" samples in to the Plant and Pest Diagnostic Clinic. It is used for out-of-state study tours that permit team members to travel to other states and countries, learning about other Extension systems and alternative horticultural practices, thus providing better insights about our own system ("He who only England knows, knows England least.") It is used to answer local concerns that statewide team activities add costs to county offices (phone costs for *BYGL* are rebated to the county offices from team funds).

The financial resources the team has received from our generous partners has allowed the ENLTT to do exactly what the funds are intended for — to nurture a dynamic team that is a better bargain for its stakeholders, a team that continues to grow in what it accomplishes.

No. 4: Teams Change Everything

Teams such as the ENLTT can help change a broader culture. This happened at Ohio State University. By 1992 the concept of agent specialization had been put in place by Extension administration. Entrepreneurial team development helped give it form, and administrative support provided ongoing nurture. Starting with ENLTT, OSU Extension now has a total of 25 highly active and creative, diverse agricultural and environmental commodity and issue teams. All provide better collegial communication and cooperative planning that ultimately improves delivery of research-based programming and development of partnerships with clientele groups.

As noted in the OSU Extension team brochure: "The development and formation of interdisciplinary commodity/issue teams is aimed at improving communication within our faculty and to better meet the needs of our commodity groups and industry clientele. These teams have focused on improved dissemination of new technology and the development of more comprehensive educational programs aimed at the commercial agriculture and horticulture industries and recreational/urban gardening. Teams are coordinated by county agents, district specialists, and associates represented across departments and colleges. Team directories are available upon request." (Ohio State University Extension, 1999).

An acknowledgment of the cultural shift engendered by these teams was highlighted in 1996 with this statement by the national Cooperative States Research Extension and Education System (CSREES) reviewers of the horticulture and crop science department at Ohio State. To quote:

"Those extension teams that the review team learned about were highly productive and able to respond rapidly to clientele. A review team member who recently reviewed extension programs in several other North Central states observed that Ohio State University was the only one of these institutions where extension personnel were moving boldly ahead with creative programs....There are some other departments and colleges in the country that have a strong relationship with their industry clients, but Ohio is near the top of the list."

No. 5: Teams Must Reinvent Themselves

ENLTT benefitted from being the first commodity team in the Ohio State University network and the positive energy that being present at the creation provides. Whether your team is the first of its kind or not, though, it is important to constantly nurture this type of creative energy. Some team-building techniques we recommend to try to keep fresh are presented here.

• What Works — What Doesn't

One of our team mottoes comes from William Shakespeare: "A lily that festers smells far worse than a weed." We use this to jettison programs that do not work for the team.

We learned early on that certain programs become more vigorous from team cooperation (*BYGL* is an example), but that others flounder. One example was a Perennial Plants School that one team member had successfully developed for years. It was in fact growing in attendance and quality.

For one brief non-shining moment it became a team activity, with shared responsibility and leadership by none. The energy was lost, the program suffered, and we quickly realized: this was not an example of the energy of synergy. It would decline as surely as a hosta planted into a hot, sunny site. This program was one that was best done by the person who had developed it rather than as a team activity. The team member re-claimed the program, and it prospers anew.

- **A Standing Invitation to Commitment**

We decided early on that membership in ENLTT was not guaranteed, simply by job description or other presumptions of interest. We formed as a team partly to foster better communication with our clientele and were concerned that if any member of our team was not involved enough to know what the team was doing, we would all suffer if that person was unable to relate what the team was doing to clientele asking about our efforts. So we do expect some level of commitment to team activities. We do not automatically assume someone to be a member of the team when hired, no matter their position. We post a standing invitation on our team directory:

"Membership on the team is based on interest and commitment to the vision and mission of the team. Potential members are encouraged to participate in some of our activities to determine if they would like to become a part of our team. If you are interested in the work of the team, contact any of the team members."

- **Mission and Vision: What We Are**

Our mission and vision statements, torturous as they are to thrash out, provide a good opportunity to think about what we are as a team. As we progress, we periodically revisit and rewrite these statements. Are we just a commercial horticulture team or do we also serve the consumer horticulture area? Should we include members from outside the university? How should we proceed to expand our funding base? These are important itches to constantly scratch.

No. 6: Teams Must Be One of a Kind

Once a team is successful, it can be tempting to try to clone it, to look for a recipe. In a way, this article might seem like just such an attempt. Though we do believe there is value in looking at such stories of teams that have something going and continue to grow (Leholm, *et al.*, 1999), without belaboring the point, it is not our intent to suggest that any team should look like ours. It is our opinion that cookie-cutter recipes for teams and teamwork, as tempting as they may be, are simply recipes for disaster. Teams work when members believe that teamwork is its own reward; energy cannot be mandated.

No. 7: Teams Empower

One of the crucial aspects of our team is its high degree of collegiality. It is non-heirarchial in nature, maximizing human resources. Leadership is shared, but often with discrete roles that can be identified for evaluation and promotion documents. Examples include our CTO (Chief Travel Officer) and our team Financial Czar.

Agent specialization plays a big role here with increasing professionalism and recognition region-wide, statewide, and nationally for many of the team members. On several occasions, at presentations at national Extension meetings, one of the authors was asked how many agents are on the team compared to the number of state specialists. The honest answer, though it could be easily determined, was a suddenly realized "I don't know." We do have a Team Coordinator for administrative contact purposes, and that person calls meetings, assembles meeting agenda items, organizes certain team contacts with clientele groups, and doubles perhaps as a CCO, Chief Communication Officer.

Another key human resource component of our team is the extent to which each team member is constantly challenged. This culture has been encouraged in a number of ways.

Point CounterPoint is a popular magazine column that two team members write for a statewide trade journal (Chatfield and Boggs, 1994-2001). This idea of open, back-and-forth debate is encouraged in team meetings and in BYGL conference calls. The edges of sensitive egos have worn off over time as people learn that different perspectives can be expressed without retribution; ideas will not be used against the other person.

The history of again and again coming into meetings with widely divergent, strongly held opinions only to emerge from the meeting with decisions reflecting the "genius of team" has built strong commitment to vigorous debate in the best tradition of academic and intellectual ferment. We encourage opening our minds to different ways of doing things.

Though we value brainstorming and the acceptance of venting any and all ideas ("multihorticulturalism," so to speak), we also have a team culture that adheres to the principles of reason. In the words of Carl Sagan (Shermer, 1997): "If you are open to the point of gullibility and have not an ounce of skeptical sense in you, then you cannot distinguish useful ideas from the worthless ones. If all ideas have equal validity then you are lost, because then it seems to me, no ideas have any validity at all." Above all — *Cogita tute!* Think for yourself.

No. 8: Teams Are Jazz

The social commentator and jazz critic Stanley Crouch (Crouch, 1995) puts into broader perspective the implications of true teamwork and fittingly sums up the ENLTT experience:

"The high degree of individuality, together with the mutual respect and co-operation required in a jazz ensemble carry with them philosophical implications that are so exciting and far-reaching that one almost hesitates to contemplate them. It is as if jazz were saying to us that not only is far greater individuality possible to man than he has so far allowed himself, but that such individuality, far from being a threat to a cooperative social structure, can actually enhance society."

References

Boggs, J. F. and J. A. Chatfield. 1995. Point Counterpoint — A Method for Teaching Critical Thinking. *Journal of Extension 33(4).*

Chatfield, J. A., J. F. Boggs, and D. J. Shetlar. 1996. The Buckeye Yard and Garden Line. *HortTechnology 6(3)*: 280-281.

Chatfield, J. and J. Boggs. 1994-2001. Point CounterPoint monthly column. *The Buckeye: The Official Publication of the Ohio Nursery and Landscape Association.*

Crouch, Stanley. 1995. *The All-American Skin Game.* Pantheon Books, New York, New York.

Leholm, A., L. Hamm, M. Suvedi, I. Gray, and F. Pasfon. June 1999. Area of Expertise Teams: The Michigan Approach to Applied Research and Extension. *The Journal of Extension. 37 (3).*

Ohio State University Extension. 1999. *Ohio State University Commodity and Issues Teams.* Available from the Department of Extension, Agriculture Administration Building, 2120 Fyffe Road, Columbus, Ohio 43210.

Shermer, Michael. 1997. *Why People Believe Weird Things.* W. H. Freeman and Company. New York, New York.

Stone, A. 2002. Ohio State University Extension's *Buckeye Yard and Garden Line* Evaluation Survey: 2001. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 186, p. 18.

Note: This article is adapted from a publication submitted in 2001 to the *Journal of Extension.*

Environmental and Cultural Problems of Ornamental Plants in Ohio: 2001

Pamela J. Bennett and Jane C. Martin

Summary

The growing season of 2001 was one of erratic weather, with wide fluctuations in temperatures and moisture levels in many parts of Ohio. In general, temperatures were warmer than normal; Cleveland, Columbus, and Cincinnati had a combined total of 38 days with temperatures reaching 90ºF or higher. During the same period in 2000, these same cities had a combined total of only six days of 90ºF or higher.

Rainfall was above average in April for some of Ohio and for much of Ohio in May, which inhibited soil preparation and planting in many locations and slowed sales of annuals and vegetable transplants at garden centers. August rainfall was above normal for the state as well. Its scattered nature resulted in large areas in the northeastern half of the state with below normal rainfall, while the western third of the state was well above normal. In contrast, precipitation was below normal across the state during January-March, June-July, and September.

The combination of high temperatures and below normal summer rainfall caused lawns in many locations to go dormant this season, with reports of permanent injury to lawns by September in some areas. Despite below normal rainfall much of the season, watering restrictions were not imposed on a wide scale. On the other hand, much of the southwest part of the state never exhibited dormancy in lawns this season due to abundant, regular rains in July and August.

After last season's rather abundant rainfall, seven regions of the state were near normal or in various degrees of moist spells on the Palmer Drought Severity Index by January 2001. Only three regions in the southern third of Ohio were rated in the "incipient drought" category.

An overview of the state's weather conditions January through September is given in the following report.

Introduction

This report includes a compilation of Ohio weather conditions and noteworthy environmentally induced and cultural plant problems in 2001. Observations were drawn from information provided in Ohio State University Extension's *Buckeye Yard and Garden Line*, the Ohio Department of Natural Resources *Monthly Water Inventory Report*, and the State Climatologist's Office for Ohio.

Pamela J. Bennett, Ohio State University Extension, Clark County; and Jane C. Martin, Ohio State University Extension, Franklin County.

Discussion

Weather Background

This section discusses precipitation and temperature reports for the season. At the end of this section is a table of statewide precipitation from January-September, and average temperatures and departures from normal for three locations in the state, April through September.

Ohio precipitation was below normal in January, February, and March. Precipitation in January was noticeably below normal, making it the ninth driest January in 119 years of weather records (Table 1). Precipitation fell as both snow and rain, with snowfall nearly normal for the eastern half of the state but below normal for the western half.

Precipitation in February was also below normal except for the extreme northwestern area of Ohio where it was above normal. Snow fell the first week of the month followed mainly by rain the rest of the month. March was dry as well, with precipitation amounts heaviest in southeastern Ohio (90% of normal), which diminished going toward the northwest (28% of normal). By the end of the first three months, soils were dry and considered workable in many parts of the state. Some areas of the state reported record low temperatures in March.

Showers and thunderstorms occurred across the middle third of the state on April 9-11, followed by some small stream flooding in the southern half of Ohio. A persistent day-long rain occurred April 20-21; the rest of the month was rather dry. April warmed up quickly, with some Extension agents commenting that temperatures were winter, spring, and summer-like within a single week. In Cincinnati, snow fell on April 1, followed by 85ºF a week later. Record high temperatures were recorded in Toledo and Columbus. During the week of April 19, temperatures ranged from 30-80ºF, and April temperatures in the state departed 4.6ºF from normal (Table 2).

May was wetter than normal statewide though it started out dry, continuing the trend at the end of April, with the exception of a few light showers and heavy rain storms in the eastern half of Ohio. However, by the end of the month, May was the 17th wettest May on record, with an average of 5.33" of rainfall, 142% of normal (Table 1). Several locations reported more than 10" of rainfall, while a station in Erie County reported the least at 2.59".

Slow-moving rain systems delivered rain each week, with the heaviest and most widespread rain falling in the last half of the month. This consistent rain did not allow soil to dry enough for working or planting in many locations, and landscapers and home gardeners often resorted to "mudding-in" plants. At the end of May, the Extension agent in Cincinnati reported +1.12" of rain for the month, but -6.13" for the year, leading him to comment, "This is the wettest drought I have ever seen." Summer-like temperatures occurred in the first half of May with normal temperatures returning in the last half.

The first half of June continued the May trend in precipitation while the last half of the month was noticeably drier (Table 1). Precipitation for the first half of the 2001 calendar year was below normal across nearly all the state, with only a few areas in southeastern Ohio receiving above normal amounts. Some below average temperatures were reported for June, particularly early in the month, though temperatures went into the 90ºFs in a few locations.

July was drier than normal, except for the west central and southwestern parts of Ohio (Table 1). Precipitation fell in the typical summer pattern of scattered showers

Table 1. 2001 Statewide Precipitation January through September

Month	Avg. Inches Precipitation	Percent of Normal
January	1.33	48
February	1.55	69
March	1.80	53
April	3.56	101
May	5.33	142
June	3.01	76
July	3.50	89
August	3.53	101
September	3.21	107

Source: Data from Ohio Department of Natural Resources — Monthly Water Inventory Reports

and thunderstorms with some producing heavy rain. Light rain occurred during the first eight days of July, followed by eight dry days. Dry conditions prevailed the rest of the month for the northern half of Ohio, but the southern half experienced showers and storms on several days with some flooding. Strong storms occurred on July 17-18 in the southwestern half of Ohio. Several Extension agents reported that soil was cracking, lawns were going dormant, and short, voluntary watering bans were issued in Franklin and Lucas counties. Meanwhile, Cincinnati recorded 8.70" of rain for July, and homeowners were mowing green lawns twice a week. Cleveland's official rain total for July was 0.62", the lowest ever in July weather records for the city.

August brought widely scattered showers to the state, along with thunderstorms and locally heavy rain (Table 1). In the western third of the state, rainfall was 119%-145% of normal, while in the eastern half, large areas experienced below normal rainfall. For example, on August 9, scattered storms crossed most of Ohio, with very strong storms in the east-central region where up to 3" of rain fell in one event. The last week of August brought welcomed rain to many areas of the state. Temperatures started out high in August and continued that way through the month.

September was wetter than normal in the western third of the state and in the north central region, ranging from 106%-147% of normal. It was drier than normal in the central, south central, and southeastern regions. State rainfall averaged 3.21", which was 107% of normal (Table 1). Early in the month, several locations around the state received heavy rainfall. For instance, Springfield (west central area) reported 4" to 7" of rainfall in the first week, with flash flooding and storm damage to trees. In the second week of September, Toledo reported 2" of rain, Cleveland 5", and Springfield another 1.6", while Columbus remained dry. The northeastern part of the state remained dry most of the month. By the last week in September, temperatures were dropping into the low 50ºFs for daytime highs, with parts of northeastern Ohio dropping into the low 40ºFs at night.

Cultural Problems

Winter Injury Report

The winter of 2000-2001 was fairly kind to most plant material. The most common problem observed in spring was damage to English ivy. Ivy in exposed areas received a good bit of damage and required heavy pruning to remove dead plant tissue. It was speculated that the damage was due to a rapid drop in December temperatures, with subsequent damage to plant tissue not properly hardened off due to the mild fall. Most plants recovered as the season progressed.

Table 2. Average Temperatures and Departures from Normal — April through September for Cleveland, Columbus, and Cincinnati.

	Cleveland		Columbus		Cincinnati	
Month	Avg. Temp. F°	Departure F°	Avg. Temp. F°	Departure F°	Avg. Temp. F°	Departure F°
April	51.4	+3.8	56.8	+5.8	57.8	+4.6
May	60.0	+2.0	63.5	+2.3	64.2	+1.3
June	68.0	+0.4	71.1	+1.9	69.7	-1.3
July	71.9	0.0	74.3	+1.1	74.2	-0.9
August	72.6	+2.2	75.2	+3.7	74.9	+1.4
September	63.1	-0.8	66.4	0.0	64.6	-2.7

Source: Average temperature is an average of all high and low temperatures recorded daily for the given location.
Data for Cleveland were taken from: www.csuohio.edu/nws/climate/cle/climatecle.html
Data for Columbus and Cincinnati were taken from: www.nws.noaa.gov/er/iln/lcdpage.htm

Number of Days 90°F or Above: April-September

Location	June	July	August	Season Total
Cleveland	3	3	5	11
Columbus	6	6	6	18
Cincinnati	1	3	5	9

Tomato Challenges

Gardeners flooded Extension offices this summer with questions regarding tomato problems. Common problems included early blight, *Septoria* leaf spot, bacterial spot and speck, wilt due to black walnut toxicity, tomato blossom drop, and general poor growth issues. Much of the state experienced poor growing conditions for tomatoes including drastic temperature and moisture changes.

Maple Problem Continues

Manganese deficiency continued to be a problem in *Acer rubrum* in many areas of the state. This deficiency is often due to a soil pH above 6.5. Manganese may become less available to plants at this pH. Drought conditions may also play a role. Symptoms include interveinal chlorosis on the leaves and young twigs and branches dying from the tips, some with a burned or blackened appearance. Severely affected plants fail to grow and may even die.

Lowering pH around established trees is difficult. Manganese chelates may be used but are only a temporary fix, not a cure. Branches sprayed in the spring with a manganese chelate may green up, but this won't last from year to year. The bottom line is placing the right plant in the right place. Soil test prior to planting to avoid this problem.

Volcano Mulching

The practice of applying mulch in a "volcano-like" mound around the base of the plant still continues, despite OSU Extension's best efforts to educate the public on mulching practices. The recommended mulching depth, depending upon the material selected, is 2" to 2.5". At this depth, the benefits of mulching — weed suppression, soil moisture retention, and temperature modification — will be achieved.

Excess mulch, especially if applied right next to the trunk of landscape plants, leads to constantly wet bark and conditions favorable for disease development. In addition, there have been some anecdotal reports of an increase in girdling roots developing in the excessively mulched areas.

References

1. The Ohio Department of Natural Resources Monthly Water Inventory Report is available at:

   www.dnr.state.oh.us/odnr/water/pubs/newsltrs/mwirmain.html

2. Dr. Jeffrey Rogers, State Climatologist, with the State Climatologist's Office for Ohio, provides current and archived weather information for several locations in the state. This information is available at:

   www.geography.ohio-state.edu/faculty/rogers/statclim.html

3. The *Buckeye Yard and Garden onLine* is available at:

   bygl.osu.edu

Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 2001

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Summary

Populations of eastern tent caterpillar (*Malacosoma americanum*) were unusually heavy in southern Ohio, southern Indiana, and Kentucky. Although highly localized, damaging infestations of common bagworm (*Thyridopteryx ephemeraeformis*), fall cankerworm (*Alsophilia pometaria*), spring cankerworm (*Paleacrita vernata*), and mimosa webworm (*Homadaula anisocentra*) occurred in various areas of Ohio.

Spotty infestations of two general defoliators, walnut caterpillar (*Datana integerrima*) and yellownecked caterpillar (*D. ministra*), were common in central and southern Ohio. An unusually heavy flight of common armyworm (*Pseudaletia unipuncta*) moths occurred throughout the western part of the state, and their attraction to blooming linden trees caused concern to homeowners.

Buckeye / horsechestnut petiole borer (*Proteoteras aesculana*) and maple petiole borer (*Caulocampus acericaulis*) were common in the southern and central parts of the state. Damage caused by the oak shothole leafminer (*Agromyza viridula*) was very evident this season on red and white oaks, particularly in the southwestern part of the state.

Spruce spider mites (*Oligonychus ununguis*) enjoyed environmental conditions supportive of population outbreaks, particularly in the fall, in southern and central Ohio. Calico scale (*Eulecanium cerasorum*) was found on dogwood in southwestern Ohio and on honeylocust and sweetgum in the northeastern part of the state. Common galls found in Ohio this season included the ash inflorescence gall, woolly oak leaf gall, wool sower gall, the jumping oak gall, and the oak spangle gall.

The multicolored Asian ladybug beetle (*Harmonia axyridis*) was the dominant home invader this season. Winged adult soybean aphids (*Aphis glycines*), a new introduced soybean pest, seemed to fill the late summer air over a number of northern Ohio communities.

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Introduction

Insect and mite activities reported in 2001 in the Ohio State University Extension's *Buckeye Yard and Garden Line (BYGL)* and

Pest Evaluation and Suppression Techniques (P.E.S.T) newsletters as well as other sources are summarized and compared to previous seasons. Unusual insect and mite activity is also reported.

Discussion

Nest-Making Caterpillars

Populations of eastern tent caterpillar (*Malacosoma americanum*) were heavy across southern Ohio, southern Indiana, and throughout much of Kentucky. Significant defoliation was observed. The 2001 season was very similar to the 2000 season regarding population distribution and densities (8). However, reports from Kentucky indicated populations were much heavier there, particularly in the Lexington area. High eastern tent caterpillar populations in the "horse region" of Kentucky, coupled with the widespread loss of Thoroughbred foals, produced a tenuous connection between the two events that captured national attention.

The equine problem became known as Mare Reproductive Loss Syndrome (MRLS) and was characterized by extremely high fetal mortality rates during the spring of 2001. More than 5,100 foals of six breeds died in Kentucky's spring epidemic. The economic impact of the foal deaths was estimated to be some $336 million through 2003, according to a study released by the Kentucky governor's office, with most of the impact — more than $300 million — hitting the Thoroughbred industry around the Bluegrass. The horse industry is Kentucky's leading agriculture cash crop.

But the problem, including loss of foals, was not confined solely to Kentucky. Reports came in of mysterious foal deaths in neighboring states that shared Kentucky's weather patterns. Similar foal deaths were reported in Ohio, including Morgan and Highland Counties in the southern part of Ohio. More foal deaths were reported in eastern Ohio, western Pennsylvania, and Tennessee as well.

Early speculation focused attention on a possible role played by the eastern tent caterpillar. While the caterpillars feed on a wide range of hosts, cherry trees are preferred, and black cherry is very common in central Kentucky. It was speculated that the caterpillars somehow served as a vehicle to carry the cyanogenic compounds contained in the cherry leaves to the horses. Observations that some symptoms appeared to be consistent with cyanide poisoning seemed to support this theory. Consequently, some horse farms implemented a black cherry removal program.

However, research conducted later in the season by the University of Kentucky, Department of Entomology indicated that it was highly unlikely the caterpillars delivered cyanide to the horses. The caterpillars are apparently very good at detoxifying the cherry leaves, and virtually all the cyanide was removed in the caterpillars' foregut. The compound was not found in the midgut, the hindgut, or the frass (excreta). It was also not incorporated into the body of the caterpillars. Although cyanide was present in the foregut, it was calculated that a horse would have to consume more than 2,000 lbs. of caterpillars in order to experience a toxic reaction.

The search for a causal agent of MRLS continues to be pursued, but as with many puzzles encountered in nature, guideposts illuminated by solid scientific evidence remain elusive. The entire story thus far provides a fascinating glimpse into the practical application of the scientific process.

As their name implies, eastern tent caterpillars produce very obvious silk nests at limb and branch forks. The caterpillars are dark with a white stripe down their backs, and they are covered with short, grayish-white hairs. They prefer to feed on trees in the family Rosaceae, particularly those in the genus *Prunus* such as cherries, although they will occasionally feed on other plants, such as ash, birch, maple, and oaks.

Eggs first hatched in late March in southern Ohio, and by mid-May BYGLers reported that mass migrations had commenced. While it is unusual for these gregarious caterpillars to leave their tents, they may take to the road in search of food after they have totally plundered their host. Consequently, these marauding hordes may suddenly appear on surrounding vegetation causing damage to unusual hosts. But, more often than not, they fail to find usable plant material. Late instars are capable of pupating, but wandering early instars often run out of luck and die before finding food.

Fall webworm (*Hyphantria cunea*) was virtually a "no show" this season. The same was true for mimosa webworm (*Homadaula anisocentra*) in most areas of the state, with the exception of northeastern Ohio. From 1995 thru 1998, the number of damaging populations of this insect seemed to be on the rise across the state, with each season worse than the season before (3, 4, 5, 6). However, during the 1999 and 2000 seasons, this web-producing pest of honeylocust failed to appear in significant numbers (7, 8), and that trend continued this past season. Significant populations did occur in northeastern Ohio, with heavy damage observed; however, these were extremely localized and not widespread.

As with the 2000 season, common bagworm (*Thyridopteryx ephemeraeformis*) populations were again spotty with small pockets of significant defoliation observed (8). This cosmopolitan woody ornamental pest overwinters as eggs inside a dead female's body which is housed in the female's bag constructed during the previous season. In the spring, eggs hatch and first instar larvae either begin feeding on the readily available host that the old female bag is attached to, or they spin threads of silk, catch the wind, and "balloon" to new hosts. The caterpillars surround themselves with bags constructed of silk and pieces of their host. The bags are enlarged as the caterpillars mature.

Once the bagworm larvae complete their development, only the male caterpillars pupate and emerge as winged adult moths. The late instar female caterpillars produce mature sex organs. They then release a sex pheromone that attracts the male moths. Mating occurs inside the female's bag, and after mating, the female's body rapidly fills with 300 to 1,000 fertilized eggs. There is one generation per year.

Eggs hatched in southern Ohio during the last week of May, and late instar caterpillars were still being found in late September in central and southwestern Ohio. Compared with previous seasons, this seemed to be somewhat of an extended tour. For example, in 1997 and 1998, eggs hatched in late May, and male moths were flying in early September (5, 6).

Applications to control this general defoliator should target early instar larvae shortly after egg hatch. Applications of insecticides made to late instar larvae may only stimulate early completion of larval development. This insect does have a number of predators and parasitoids that may play a significant role in reducing population densities. For example, during a Christmas tree growers clinic held this past season in southwestern Ohio, participants observed a significant number of bags with gaping holes ripped in their sides indicating that a hornet, yellowjacket, or paper wasp had extracted the caterpillar to feed to its young. Caterpillars with their bodies filled with a single, grub-like parasitic wasp larva were also found in high numbers.

Other Caterpillars

Localized outbreaks of fall cankerworms (*Alsophilia pometaria*) and spring canker worms (*Paleacrita vernata*) were observed in southern Ohio. Despite their common names, which indicate the seasons when the flightless female moths lay their eggs, both of these species of loopers, or inchworms, appear as larvae in the spring. They consume all of the leaf except the midvein and will feed on a number of deciduous trees including oak, linden, elm, apple, and beech. Both species have a single generation per year.

Aside from being general defoliators, the caterpillars are also capable of becoming a significant nuisance pest. Caterpillars are able to spin down from trees on silk threads. This behavior is usually only expressed when the caterpillars are about to pupate. However, during high population outbreaks, the caterpillars may vacate trees throughout their larval development in search of food. Large numbers of caterpillars descending on silk threads onto cars, pets, people, etc., is a disconcerting experience for affected homeowners. Such an event was observed in the Cincinnati area this past season.

In the spring, common armyworm (*Pseudaletia unipuncta*) caterpillars grabbed the attention of farmers in western Ohio with large populations devouring wheat fields and marching into corn fields to feed on those plants as well. The armyworm caterpillar is primarily a grass-feeding insect. While there were isolated reports of damage to turfgrass, the primary problem created by the large number of caterpillars was the correspondingly large moth (adult) populations that occurred in late June.

BYGLers throughout western Ohio reported numerous phone calls regarding large numbers of armyworm moths clustering in and around linden trees. The linden trees were in full bloom and producing large quantities of nectar which attracted the moths. Callers reported that the trees almost seemed to pulse with the moths flying in and out of the trees. Fearing their linden trees were under attack, many asked for control recommendations. Fortunately, the armyworm moths were causing no harm to the trees because they are nectar feeders. Insecticide applications were not only not justified, they would have done more harm than good. Several other species of insects are also highly attracted to the blooming linden trees, including other moths, butterflies, and honeybees. These insects would also have been killed by an insecticide treatment.

Two general defoliators in the genus *Datana* were observed in central and southern Ohio in early August. Walnut caterpillars (*D. integerrima*) feed on their namesake as well as hickory and oak. Yellownecked caterpillars (*D. ministra*) possess a more cosmopolitan palate, feasting upon walnut, hickory, and oak, as well as crabapple, cherry, maple, elm, beech, linden, birch, black locust, azalea, sumac, and boxwood. Pockets of heavy defoliation from both species were observed, but yellownecked caterpillars were more commonly found and seemed to be more widespread. Populations of this caterpillar have been on the rise over the past seasons (6, 7, 8).

Heavy infestations of late instar ailanthus webworms (*Atteva punctella*) on tree of heaven (*Ailanthus altissima*) were observed at two locations in southwestern Ohio in late September. The webworms are capable of defoliating their odoriferous namesake and may feed on stem tissue once all leaves are devoured. For example, tree of heaven seedlings/suckers and saplings were found to be seriously damaged, if not killed, by caterpillars gnawing away the tender bark. Such an observation would normally cause concern if damage occurred on a preferred tree species, but since the damage occurred on a nonnative, invasive tree, the webworms were applauded for their biocontrol efforts! Small populations of this insect were also observed in southwestern Ohio during the 1998 season (6).

Larvae of this ermine moth produce nests by pulling several leaflets into a network of loose webbing. They then live within the nests, consuming the leaflets bound by the webbing. The webworm caterpillars can grow up to 1" to 1-1/2" long, and they have a wide, light greenish-brown stripe down their backs and several thin, alternating white and olive green stripes along their sides. They are sparsely covered with short, erect hairs, which help to suspend the caterpillars within the webbing. When disturbed, the caterpillars move backwards out of the nest and drop towards the ground on strands of silk.

Sawfly Defoliators

Overwintered eggs of the European pine sawfly (*Neodiprion sertifer*) hatched in mid-April in central and southern Ohio. Last season, eggs hatched in southern Ohio in mid-March (8). In 1998 and 1999, eggs hatched in that part of the state in early April (6, 7). Conifer hosts include mugo, table top, Scotch, red, Jack, and Japanese pines. Larvae feed in colonies, but this sawfly has only one generation per year, and larval development is generally completed before new growth occurs. Consequently, damage is usually confined to the previous years' needles. Although this sawfly was commonly found during the spring, no significant outbreaks were reported.

The redheaded pine sawfly (*N. lecontei*) is a more serious conifer pest and appeared to be on the rise in southern Ohio during past seasons (1, 2, 7, 8). Unlike the European pine sawfly, the redheaded pine sawfly has at least two generations per year, and it spends the winter as late-instar larvae in a cocoon. During the spring, this sawfly completes its development, emerges, and lays eggs in needles. By the time eggs hatch, new growth has usually started to elongate. Larvae feed in colonies on new and old needles, and occasionally on the tender bark of young twigs, particularly during the second generation. Because old and current needles are eaten, this sawfly is considered to be one of the most destructive of the pine sawflies. Destructive populations were observed during the 2001 season on mugo pines in landscapes and on Scotch pines in Christmas tree plantations in southwestern Ohio.

As with last season, pockets of high populations of dusky birch sawfly (*Croesus latitarsus*) were observed in Cincinnati, Ohio, this season (8). This sawfly also has two generations per year, and it feeds on birch leaves. Early instar larvae skeletonize leaves and later instars consume entire leaves, except for the mid-vein. All instars have shiny black head capsules and distinct black spots on their bodies, but middle-instar larvae are greenish-gray and become yellowish-green when they reach the last instar stage. All instars feed in colonies, lined up head-to-tail along leaf margins. When disturbed, the larvae exhibit a characteristic defense posture — they hang on with their prolegs and form their bodies into a distinct "S" shape. Entire colonies practice this defense posture in unison, forming a row of Ss, which is a great self-identifier — S for sawfly!

Leafminers

As with previous seasons, adults of three leafmining sawflies in the genus *Fenusa* were on the wing in northeastern Ohio in late April (6, 7, 8). These were the elm leafminer (*F. ulmi*), European alder leafminer (*F. dohrnii*), and birch leafminer (*F. pusilla*). Larvae of these sawflies mine the leaf parenchyma, producing large blister-like, reddish-brown blotch-mines, which usually extend from the leaf margin toward the midvein. The elm leafminer has one generation per year, and the alder and birch leafminers both have three generations.

Damage caused by the oak shothole leafminer (*Agromyza viridula*) was once again very evident this season on red and white oaks, particularly in the southern and western parts of the state. Damage is caused by the piercing-sucking feeding activity of the adult fly and by spot-mines produced by the larvae. There is one generation per year and all activity is concentrated on newly expanding leaves. Adult feeding holes and abandoned larval leaf mines enlarge along with the expanding leaf tissue. Consequently, small holes become large and may be mistaken for damage caused by a general defoliating insect or by "oak tatters." All reports of damage this season referenced 1/8- to 1/2-inch diameter holes that seemed to "appear" on leaves in June.

The annual ravaging of black locust leaves by locust leafminer (*Odontota dorsalis*) occurred this season throughout much of Ohio (3, 5, 6, 7, 8). The digitate blotch-mines produced by the larvae coupled with the skeletonized leaves produced by the adult beetles caused many trees to become completely brown by late summer, particularly in the southern part of the state.

Borers

Infestations of several stress-related borers appeared to be common during the 2001 season. These included conifer bark beetles (family Scolytidae, genera *Dendroctonus* and *Ips*), which produce characteristic "shotholes" in the bark of infested trees, as well as the much larger metallic flatheaded beetles (family Buprestidae) that attack deciduous trees, such as bronze birch borer (*Agrilus anxius*), twolined chestnut borer (*A. bilineatus*), and flatheaded appletree borer (*Chrysobothris femorata*). These observations were virtually a repeat of previous seasons (5, 7, 8).

Damage caused by the buckeye/horsechestnut petiole borer (*Proteoteras aesculana*) has become common in southern and central Ohio (6, 7). During the 2000 season, significant damage was also observed on buckeyes in the northern part of the state (8). The trend continued this past season with damage being reported throughout the state. There are two generations per year, and symptoms produced by the first generation began appearing in late April. Larvae of the moth bore into leaf petioles causing the new leaves to turn black and droop. Leaves remain attached to the trees and symptoms in the spring superficially resemble freeze/frost injury.

The maple petiole borer (*Caulocampus acericaulis*), a sawfly that bores into the petioles of its namesake, was also active throughout much of the state. Unlike the buckeye petiole borer, feeding activity of the maple petiole borer causes affected leaves to fall from the tree. Heavy leaf drop in May often signals an infestation of this insect. The tiny sawfly tunnels out the inner tissues of the petiole causing the leaves to turn brown, droop, and the petioles to break a short distance from the leaf blade. Larvae remain inside the portion of the petiole attached to the twig, so raking and destroying fallen leaves will not reduce the population. There is only one generation per year and damage is seldom severe enough to cause serious harm to the tree.

Lace Bugs

Lace bugs were once again a significant pest of landscape and nursery plants throughout the state with a number of species producing serious injury to their hosts. Lace bugs that attack deciduous plants overwinter as adults on the bark of their hosts, while those attacking broadleaf evergreens overwinter in the egg stage on the underside of leaves. Once the eggs hatch, feeding damage to last year's foliage is initiated. Thus, the earliest damage reports for the season usually involve lace bugs on broadleaf evergreens.

In late May, damage caused by azalea lace bug (*Stephanitis pyrioides*) and andromeda lace bug (*S. takeyai*) was evident on their namesakes in southern Ohio. Damage caused by hawthorn lace bug (*Corythucha cydoniae*) and oak lace bug (*C. arcuata*) became evident by mid June in southern Ohio. Hawthorn lace bug is also found on cotoneaster, pyracantha, flowering quince, crabapple, mountain-ash, and shadbush. Oak lace bug populations were particularly heavy in the southwestern and central parts of Ohio.

By early August, a number of other lace bugs had also been observed causing characteristic stippling damage to their namesakes. These included sycamore lace bug (*C. ciliata*), walnut lace bug (*C. juglandis*), and rhododendron lace bug (*S. rhododendri*). The unusual chrysanthemum lace bug (*C. marmorata*) that lives on both the upper and lower leaf surfaces of its host caused damage to several herbaceous perennials, particularly asters.

Other Sucking Insects

A number of species of soft scales seemed particularly abundant during the 2001 season. These included cottony maple leaf scale (*Pulvinaria acericola*), calico scale (*Eulecanium cerasorum*), Fletcher scale (*Parthenolecanium fletcheri*), and magnolia scale (*Neolecanium cornuparvum*).

Cottony maple leaf scale ovisacs were observed on the underside of sassafras leaves in southwestern Ohio in June. The ovisacs are conspicuous, elongated, white, cottony egg masses that may contain more than 2,500 eggs. By early September, crawlers had emerged from these ovisacs and settled along the leaf veins on the underside of the leaves. These observations illustrated both the wide host range of this insect and the vulnerability of this scale to late season control measures. Despite its common name, this scale will infest a wide range of host plants including dogwood, hollies, andromeda, honeysuckle, and sourgum.

Calico scale (*Eulecanium cerasorum*) continues to become more common in Ohio (7, 8). As with last season, this insect was found on dogwood, magnolia, and sweetgum in southwestern Ohio and on honeylocust and sweetgum in the northeastern part of the state. Additional hosts of this soft scale include maple, magnolia, tuliptree, and ornamental fruit trees. The scale normally does not kill trees, but it is capable of producing large quantities of honeydew that may be colonized by sooty molds, giving the host an unsightly appearance.

This globular blackish-brown soft scale is about 1/4 inch in diameter, and it is easy to recognize because of the distinct rows of squarish, white patches on the back. Its life cycle is similar to European fruit lecanium scale. Calico scale has one generation per year and overwinters on twigs as partially grown nymphs. As the spring progresses, the nymphs feed, molt, and mature into globular adults. In late spring to early summer, eggs are laid, and the hatching nymphs migrate to the undersides of leaves. In late summer to early fall, the nymphs molt to second instars and move from the leaves to stems, branches, and the trunk where they overwinter. Effective control strategies include insecticide applications made in July or August, targeting the first instar nymphs on leaves, or dormant oil applications made in early spring to kill overwintering second instar nymphs.

Mites

Overwintered eggs of the spruce spider mite (*Oligonychus ununguis*) hatched in southwestern Ohio in early April and in the northeast part of the state by the middle of April. Adults of this cool-season mite appear in the spring and fall. The summer and winter months are spent in the egg stage. Mite populations expanded rapidly during the dry weather experienced during March and April in the southern part of the state. By the end of April, some areas of southern Ohio were eight inches below average in rainfall. However, the rainfall deficit was eliminated by heavy rains in May, June, and July. Consequently, spruce spider mite populations plummeted with adult mites being washed from the trees in May. Populations did not recover in that part of the state throughout the spring and early summer.

Fall populations fared much better. Dry periods in September and October allowed populations to build to damaging levels in both southern and central Ohio. For example, severe damage and heavy webbing were observed on Colorado blue spruce in late September in the Dayton, Ohio, area.

Warm-season mite populations were also adversely affected by the weather this past season. The two-spotted spider mite (*Tetranychus urticae*) failed to repeat the high numbers observed during the 2000 season (8). High populations of other warm season mites were also rarely observed during the 2001 season. These included oak spider mite (*O. bicolor*), maple spider mite (*O. aceris*), and the honeylocust spider mite (*Eotetranychus multidigituli*).

Gall Makers

While a number of eriophyid mite species were found in abundance in Ohio landscapes, the most dramatic example this past season was the ash inflorescence gall produced by the mite, *Eriophyes fraxinivorus*. While these galls look like small witches' brooms growing just beneath the leaves, they cause no injury to the tree since only the flower parts are affected.

The USDA Agriculture Handbook Number 573, *An Illustrated Guide to Plant Abnormalities Caused by Eriophyid Mites in North America,* gives an excellent description of this gall. The narrative reads: "The infested inflorescence shows swollen and fused pedicels of individual flowers, often involving the peduncle or stalk. There is considerable distortion, and when the infestation is severe, every inflorescence is galled. Fully developed galls are conspicuously brownish, lumpy, and unsightly, usually remaining attached to the twigs from one season to the next."

As with previous seasons, samples of oak galls were common in OSU Extension offices throughout the state. A few of the more prevalent types found in Ohio landscapes this past season included the woolly leaf gall, the wool sower gall, the jumping oak gall, and the oak spangle gall. All are produced by tiny wasps in the family Cynipidae, and none cause significant harm to the host tree.

As their descriptive name implies, the woolly leaf gall looks like someone stuck a dense wad of light brown wool to a leaf vein. The galls are produced by the cynipid wasp, *Andricus fullawayi*, and are found on the underside of leaves where they are usually attached to the midvein, although they occasionally arise from lateral veins. They range in size from pea-sized to the diameter of a quarter. When oak leaves turn color in the fall, the galls often detach and fall to the ground. Large numbers littering the ground beneath an oak tree may cause concern, but no harm has been done to the tree.

The wool sower gall looks similar to the woolly leaf gall. However, it arises from the twigs. The galls are produced by the cynipid wasp, *Callirhytis seminator*. Immature galls can be cut open to reveal the interesting seedlike structures that contain the immature wasps. The off-white, woolly galls may expand to 1-2" in diameter. As with the wooly leaf gall, once the wasps mature and emerge as adults, the gall drops from the tree.

Jumping oak galls are produced by the cynipid wasp, *Neuroterus saltatorius*. This is by far the most entertaining of the oak galls. These light-tan, globular galls are about the size of a sesame seed and hang from the underside of the leaf. Each gall contains a single larva. When the galls mature, they drop from the leaves carrying the wasp larva to the ground. Once on the ground, they display an interesting behavior that gives them their common name. Larval activity causes the galls to jump around, as high as several inches! There has been no clear explanation for this unusual behavior, but it is speculated that the jumping activity carries the galls into soil crevices where the larvae are protected for the winter.

The flattened oak spangle galls resemble the spangles sown onto costumes. They form on the underside of the leaves and are attached at their centers by a tiny, post-like structure. The overall effect makes the leaves look like they are sprouting octopus suction cups! Immature galls are white to whitish-green. Mature galls are approximately 3/16" in diameter and as they mature, the galls turn pinkish-white and eventually purplish-brown. Mature galls detach from the tree carrying cynipid wasp pupae to the ground where they overwinter. Large numbers of galls may detach during rain storms and collect in puddles beneath infested trees. For example, dramatic displays of piles of the purplish-brown, saucer-shaped galls were found washed into gutters after a heavy rain this past season in southwestern Ohio.

Turf Pests

White grub populations were generally down this year, particularly in central and northern Ohio. It was speculated that drought conditions in those areas of the state during July and early August, the time of the year when adults lay their eggs, may have been severe enough to suppress egg development and/or kill first instar larvae.

As with the 1998, 1999, and 2000 seasons, bluegrass billbug (*Sphenophorus parvulus*) was commonly found throughout Ohio (6, 7, 8), and areas of localized damage were observed. Although there were a few cases of hairy chinch bugs (*Blissus leucopterus hirtus*) causing injury to home lawns in southwestern Ohio, populations were generally down this season across the state. Most Ohio golf courses experienced two generations of black cutworms (*Agrotis ipsilon*), but the black turfgrass ataenius (*Ataenius spretulus*) was uncommon.

A localized infestation of an unusual turfgrass pest, grass thrips (*Anaphothrips obscurus*), was observed in early August in southwestern Ohio. Thrips have unusual mouthparts, termed "rasping-sucking." They use their mouthparts to rasp the plant tissue and then they suck the exuding sap. They can also use their mouthparts to deliver a painful bite to people. Their bite may cause the afflicted to believe they are being bitten by fleas or lice. This practice gives the grass thrips another common name — oat lice.

Grass thrips are tiny black or yellowish-black insects, measuring about 1/8" long. They have four very thin, veinless, feather-like wings. The wing margins are fringed with close-set long hairs. Wings are laid back over the body while at rest. Nymphs are creamy-white and wingless. Thrips move rapidly, and they will quickly vacate their host when disturbed.

Feeding damage on the grass blades looks similar to the stippling caused by lace bugs. Indeed, the underside of the blades may even be covered by small, shiny-black deposits that look similar to lace bug excrement. When the feeding injury coalesces, the grass blades become silvery or whitish in appearance. Although somewhat rare, this turf pest can occasionally develop significant populations, particularly during the hotter summer months. Applications for controlling this thrip are seldom recommended since the damage, although noticeable, is usually not significant.

Household and Nuisance Pests

The most common and challenging home invader this past season was the multicolored Asian lady beetle (*Harmonia axyridis*). The same was true last year (8). A new OSU Extension Fact Sheet #HSE-1030-01, titled *Multicolored Asian Lady Beetle,* provided information helpful to homeowners dealing with this pesky intruder. The Fact Sheet is available at OSU Extension county offices or on the Web at: *http://ohioline.osu.edu/hse-fact/1030.html.*

Boxelder bugs (*Boisea trivittata*) took second in the 2001 home invader competition. Although boxelder bugs are usually considered a spring and fall pest, BYGLers reported finding high numbers around Ohio homes well into the summer. For example, in late June, Amy Stone's (OSU Extension, Lucas County) very observant children discovered "red mulch" at a neighbors home. Upon closer inspection, Amy found the red tint was actually being furnished by teeming masses of boxelder bug nymphs.

Adults are 1/2" long, elliptical in shape, and have flat backs. They are predominantly brownish-black, but their thorax has three longitudinal red stripes and their wings are trimmed in red. The nymphs have bluish-black legs, wing pads, and thorax, but their most obvious feature is a large, oblong, bright red abdomen.

Boxelder bugs are generally most obvious in the fall, when gangs of adults loiter around homes, checking out places to spend the winter. Their occasional breaking and entering earns them a reputation as a nuisance pest and nearby boxelder trees are usually implicated in the crime. However, large numbers of immature bugs are sometimes found in the spring and early summer on and around other landscape plants.

While the bugs seem to prefer to feed on boxelder seeds, they may also suck sap from seeds, leaves, and tender twigs of maple and ash, and from the fruit of plum, cherry, apple, peach, grape, and strawberries. Their sampling of fruit causes scarring and dimpling which may mimic plant bug injury. Damaging populations are seldom seen on these alternate hosts, but the insect should be monitored and a suppression spray considered if the "red mulch" syndrome is observed beneath fruit trees.

New and Unusual

In mid-August, soybean aphids (*Aphis glycines*), a relatively new pest of soybeans in Ohio, began to cause problems in urban areas. As populations of the aphid matured and soybeans declined, winged adults were produced for migration to search for new food sources or overwintering sites. The winged adults were caught on air currents and carried to villages, towns, and cities. In Toronto, Canada, a major league baseball game was delayed while they closed the roof on Toronto's SkyDome to try (unsuccessfully) to exclude the aphids from the playing field.

Residents of Cleveland and other northern Ohio cities also experienced similar invasions of the aphid. So many aphids filled the air in some residential areas that people had difficulty moving outdoors without breathing aphids, eating aphids, and getting aphids in their eyes and hair. Although a nuisance pest, the aphids were probably welcomed treats for a number of predators, including lady beetles. Indeed, it was speculated that the huge numbers of this aphid may have played a role in encouraging the burgeoning numbers of multicolored Asian lady beetles observed this past season.

The soybean aphid is an exotic species from Asia. It is a small, yellow aphid with distinct black cornicles (tail pipes out of the back of the abdomen). The soybean aphid has a complex life cycle with as many as 15 to 18 generations each year. Two very different types of host plants are required for the soybean aphid to complete its life cycle. The aphid spends the growing season feeding and reproducing on soybeans; then it overwinters as an egg on buckthorn (*Rhamnus* ssp.) plants.

Literature Cited

1. Chatfield, J. A., J. F. Boggs, P. Kauffman, D. J. Shetlar, N. Taylor, and R. H. Zondag. 1993-1994. Ornamental Plant Problems in Ohio: 1993. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 142. pp. 28-31.

2. Chatfield, J. A., D. J. Shetlar, N. Taylor, J. F. Boggs, P. J. Bennett, R. H. Zondag, M. A. Ellis, and A. Baumgard. 1993-1994. Ornamental Plant Problems in Ohio: 1994. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 142. pp. 24-27.

3. Boggs, J. F., D. J. Shetlar, G. Y. Gao, D. Balser, D. C. Caldwell, R. H. Zondag, and J. A. Chatfield. 1995. Plant Insect Pest Problems in Ohio: 1995. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 152. pp. 38-41.

4. Boggs, J. F., D. J. Shetlar, J. A. Martin, P. J. Bennett, J. A. Chatfield, D. R. Balser, and G. Y. Gao. 1996. Insect and Mite Activity Noted in Ohio: 1996. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 154. pp. 17-22.

5. Boggs, J. F., D. J. Shetlar, J. C. Martin, P. J. Bennett, J. A. Chatfield, G. Y. Gao, and C. Carlson. Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 1997. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 157. pp. 18-25.

6. Boggs, J. F., D. J. Shetlar, J. C. Martin, P. J. Bennett, J. A. Chatfield, and G. Y. Gao. Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 1998. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 165. pp. 41-49.

7. Boggs, J. F., D. J. Shetlar, J. C. Martin, D. E. Dyke, P. J. Bennett, G. Y. Gao, D. R. Balser, and J. A. Chatfield. Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 1999. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 173. pp. 25-35.

8. Boggs, J. F., C. E. Young, D. J. Shetlar, E. A. Draper, G. Y. Gao, J. A. Chatfield, J. C. Martin, and P. J. Bennett. Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 2000. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 177. pp. 29-40.

9. Lexington *Herald-Leader*, Lexington, Kentucky. May 12, 2001, Foal losses don't appear to be slowing. October 16, 2001, Foal loss exceeds 5,100, study says.

Infectious Disease Problems of Ornamental Plants in Ohio: 2001

James A. Chatfield, Nancy A. Taylor, Erik A. Draper, Stephen Nameth, and Joseph F. Boggs

Introduction

Disease summaries for 2001 were derived from the OSU Extension *Buckeye Yard and Garden Line* (*BYGL*) electronic newsletter, reports of the C. Wayne Ellett Plant and Pest Diagnostic Clinic (PPDC), and other reports. As always, environmental conditions unique to the particular growing season played a big part in the profile of diseases for 2001.

Diseases of Note in 2001

1. Fireblight on Callery Pear and Crabapple

Callery Pear

This bacterial disease (*Erwinia amylovora*) was unusually severe on Callery pears in areas of Kentucky, southern Indiana, and southern Ohio and to a lesser extent further north in 2001, presumably due to warm, wet weather events that occurred during bloom. This is because such conditions, especially temperatures above 60ºF, are known to encourage blossom infections. The number and severity of infections surprised many, especially since early spring conditions seemed generally dry. The spotty occurrence of the outbreaks may relate to localized showers during peak bloom times.

Symptoms include numerous infections (in some cases dozens or hundreds) along the stems where blossom clusters developed. Affected plant tissue is browned and blackened with discolored leaves remaining on the tree and shoots often wilted in a "Shepherd's crook"-like fashion. In most years, fireblight on Callery pears is far less severe in terms of the number and extent of infection than fireblight on some of the more susceptible fruiting pear and apple cultivars.

One of the typical control recommendations for fireblight has always been to prune infected shoots 6" or 8" below the infected area to limit the spread of the disease. However, there is a little more to this disease than meets the eye, or pruners. John Hartman, Extension Plant Pathology with the University of Kentucky, wrote an extensive article on fireblight in the June 2001 issue of *Kentucky Fruit Facts (http://www.ca.uky.edu/HLA/fruifact/)*.

Hartman wrote that growers and gardeners with fireblight infected trees are often

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tempted to remove infected branches. In many cases, this would be the wrong strategy, because removing branches can encourage new shoots to develop, and these new shoots would also be susceptible to new infections. If fireblight strikes are discovered early, before leaves have turned completely brown, timely removal of infected shoots can help slow the spread of the disease. However, most growers and gardeners do not discover the disease early enough for this to be helpful.

For most growers, Hartman recommended letting the disease run its course, allowing the tree defense to stop fireblight spread within the tree. Dead shoots and branches should be removed in winter when there is little chance of spreading this disease.

Crabapple

In the National Crabapple Evaluation Program plots at Secrest Arboretum on the Wooster campus of the Ohio State University's Ohio Agricultural Research and Development Center, the incidence of fireblight is typically minor in most years. However, 2001 turned out to be a banner year for fireblight on crabapple, much worse than any in the past 10 years.

Young plants of several crabapple cultivars developed severe fireblight strikes that blighted nearly half of the foliage and stem tissue. These heavily affected cultivars included 'Golden Raindrops,' 'Sinai Fire,' 'Foxfire,' and 'Silver Moon.' Nevertheless, most of the cultivars in the plot that exhibited fireblight this year had only a minor incidence, and the majority of cultivars in the plot had no fireblight.

It will be intriguing to follow the incidence of fireblight in the trees that were badly damaged this year to see if the problem worsens in coming years.

2. Anthracnose Diseases of Trees

There are a number of different anthracnose diseases on trees in Ohio. It was an average year in general for incidence of these diseases. Some short profiles of common anthracnose diseases follow.

Sycamore Anthracnose

Sycamore anthracnose (*Apiognomonia veneta*) is a potentially serious disease of American sycamore and to a lesser extent London planetree. Susceptibility of London planetree varies considerably with seed source. The fungus overwinters on twig tissue on the tree with spores splashing to new buds, shoots, and leaves in the spring, with disease being enhanced by cool, wet conditions during shoot and leaf development. Considerable defoliation, sometimes with complete leaf loss, occurs on many trees by late spring in some years. Trees typically re-leaf by early to mid summer and are less susceptible to continued infections because of warmer, drier conditions.

Maple Anthracnose

Maple anthracnose (*Kabatiella apocrypta*) is generally not severe on maple but can cause considerable unsightliness from brownish leaf blotches and some leaf drop when moist weather conditions make the disease particularly severe. The most common symptoms include brownish discoloration along veins, varying from discrete spots to irregular patches of discoloration bordered by veins.

Dogwood Anthracnose

Dogwood anthracnose (*Discula destructiva*) has become prominent in certain areas in recent years, especially on flowering dogwood (*Cornus florida*). Dogwood anthracnose is most severe where cool, moist conditions occur during the summer, such as in higher elevation areas, and in densely vegetated shady sites with poor air movement. Leaf symptoms include irregular brown blotches bordered in purple on upper leaf surfaces. Stem symptoms include twig cankering and dieback, often with visible fungal fruiting bodies on dead twigs. Attached wilted, brown leaves often persist into the next spring instead of dropping in the fall.

Ash Anthracnose

Ash anthracnose (*Gnomoniella fraxini*) commonly causes at least some leaf drop on landscape ashes each year, with blotchy grayish to brownish blotch-like lesions occurring on ash leaflets.

Karen Jacobs and co-workers at Morton Arboretum in Chicago presented data this summer from their ash anthracnose study in a research poster session at the International Society of Arboriculture annual meeting in Milwaukee, Wisc. Two interesting points follow.

First, over a three-year period, they found that ash anthracnose incidence was considerably higher on green ash (*Fraxinus pennsylvanica*) than on white ash (*Fraxinus americana*), which is counter to what is commonly thought to be the case.

Second, in a look at eight different species of ash, the key factor in ash anthracnose incidence over the years appeared to be how early the particular species leafed out in the spring. Those that tend to leaf out earliest seem to exhibit the most ash anthracnose. The researchers note that this needs to be looked at over a longer period of time and that cultivar studies are needed. However, this data is interesting and consistent, considering that the key environmental factors for infection by the ash anthracnose fungus are cool and wet — and on average the earlier, the cooler and the wetter.

3. Juniper Problems

Nancy Taylor in the Plant and Pest Diagnostic Clinic (PPDC) reported receiving a juniper sample with both *Phomopsis* twig blight causing dieback of branch tips, and *Phytophthora* root rot causing death and decay of the root system. It is not uncommon for plants to be infected with more than one pathogen and symptoms of one disease may mimic, enhance, or obscure symptoms of another disease.

Often, one of the diseases is more serious, as was the case here. *Phomopsis* twig blight can certainly make a juniper look bad, but it is seldom a killer. As we constantly remind *BYGL* readers, the best way to sort things out, so a management strategy can be developed, is to send a sample to the C. Wayne Ellett Plant and Pest Diagnostic Clinic (PPDC).

We also stress the importance of considering components of the disease triangle (pathogen, susceptible host plant, environment conducive to disease) to plan strategies to avoid and/or manage disease problems.

The "environmental" side of the triangle plays a pivotal role in managing *Phytophthora* root rot. Indeed, the pathogen is sometimes tagged as one of the "Dr. Treevorkians" of the soil. It often finishes off roots that are already stressed by an environmental problem, such as heavy moisture caused by poor drainage.

While the landscaper did the right thing by sending the sample, their response to Nancy's recommendation that drainage be improved, was that drainage could not be improved. Unfortunately, such is often the case in landscape installations — major changes are beyond the control of the landscape manager. But, at least the landscaper will know what killed the juniper.

Furthermore, when plant selection or site preparation is in their purview, the manager can learn how to avoid the "same darn thing over and over again."

4. *Verticillium* Wilt Disease

BYGLive! participants in Cincinnati spent some time viewing a smoketree that exhibited classic symptoms of *Verticillium* wilt disease (*Verticillium albo-atrum*). Leaves were becoming scorched, drooping, and eventually turning brown while remaining attached to the tree. An examination of the affected branches revealed vascular streaking in the conducting system of the plant's stems.

The *Verticillium* fungus has a broad host range of plants that it infects, including many common woody ornamentals. A partial list of common susceptible hosts includes ash, azalea, barberry, catalpa, cherry and other stone fruits, daphne, elm, honeysuckle, lilac, magnolia, maple, Russian olive, peony, privet, redbud, rose, serviceberry, smoketree, spiraea, tree-of-heaven, tuliptree, viburnum, and yellowwood.

Plants with good resistance include all gymnosperms (pine, spruce, fir, hemlock, yew, ginkgo, etc.), and all monocots (grasses, sedges, lilies, palms, etc.). A partial list of other resistant plants includes mountainash, beech, birch, crabapple, dogwood, sweetgum, hackberry, hawthorn, hickory, holly, linden, honeylocust, oak, pawpaw, pear, planetrees, rhododendron, walnut, and willow.

The *Verticillium* fungus infects plants through the roots, moving upward by means of the vascular system. Environmental factors that affect *Verticillium* infection and subsequent disease development include moisture stress, root injury, damage from salts, transplant injury, and other factors that affect root health.

Indeed, the factors affecting wilt incidence and severity include all three angles of the disease triangle:

- Host plant susceptibility to infection by the *Verticillium* pathogen.
- The effects of environmental factors on infection.
- Degree of virulence of the strain of the *Verticillium* pathogen.

The *BYGLive!* participants discussed what should be done, and the first conclusion was that the disease should be confirmed by sending proper samples to the PPDC. While the smoketree appeared to have all the "right" symptoms, other problems can cause exactly the same symptoms. For example, streaking of the vascular tissue can be caused by other nonpathogenic fungi. On the other hand, some trees, such as ash, are notorious for confusing the issue by seldom expressing this vascular discoloration symptom of a *Verticillium* infection.

Samples sent to the Clinic for confirmation should include twigs with entire leaves that are still attached to the tree, but exhibit scorch symptoms. The fungus may be isolated from the leaf petioles. To allow for isolation of the fungus from branch tissue, 6" to 8" sections of wood about 0.75"-1" in diameter taken from branches with scorched leaves, should also be sent. As with all samples sent to the Clinic, it is best to send them early in the week and by "overnight" delivery.

5. Daylily Rust

Daylily rust, caused by the fungus *Puccinia* sp., was identified in the state of Ohio for the first time in the summer of 2001. The disease was originally found in the southern United States in 2000 and more recently found in Kentucky and Indiana.

Depending on the daylily variety, foliar symptoms can range from very severe to mild. Spores of the causal fungus can germinate and infect the host particularly during periods of high moisture.

The fungus also has a secondary weed host, *Patrinia* sp. There are about six species of *Patrinia* that are grown in the United States as ornamental plants. The fungal spores are spread from plant to plant by human contact, wind, and wind-driven rain. One week to 10 days following infection the affected leaves become covered with pustules of rust-colored spores. These new spores can then act as a source of infection for other daylilys.

Plants suspected of rust infection should be sampled and sent to a university or state diagnostic clinic for proper identification. In some cases, rust can be confused with leaf-streak disease. A variety of fungicides have been recommended for rust disease management. These include Banner MAXX, Heritage, Contrast, and Systhane. Infected plants should be removed (cut-back) of symptomatic leaves prior to fungicide application. Symptomatic leaves need to be destroyed.

Research is being conducted at the Ohio State University on the overwintering capabilities of the rust spores in the northern latitudes. In the spring of 2002, field trials will be conducted on the Waterman complex under the direction of Mac Riedel and Steve Nameth to determine fungicide efficacy and varietal differences in susceptibility to this potentially destructive disease.

6. *Cristulariella* Leaf Spot of Maple

Many in southern Ohio noticed this zonate, or bull's-eye, fungal leaf spot of maples in 2001. As noted in *Diseases of Trees and Shrubs* by Sinclair, Johnson, and Lyon: "Target spots have light centers and alternating light and dark concentric rings."

During moist weather, lesions may coalesce and in some cases defoliation may occur. On the undersurface of lesions, with the help of a hand lens, you can often see conical or globular crystalline masses containing propagules of the fungus. This disease is typically a mid- to late-season disease. It is usually not prevalent each year, so controls are generally not warranted.

7. Orange Rust of Brambles

All right, you caught us — brambles are rarely, if ever, considered ornamental plants. Nevertheless, *Buckeye Yard and Garden Liners* Erik Draper and Dave Dyke are such fructophiles that they could not resist repeatedly reporting this dramatic disease in the *BYGL* this summer, so here is a short orange rust rap.

Orange rust (*Gymnoconia peckiana*) is the most important of several rust diseases that attack brambles. All varieties of black and purple raspberries and most varieties of erect and trailing blackberries are very susceptible. Orange rust does not infect red raspberries.

Infected plants can be easily identified shortly after new growth appears in the spring. Newly formed shoots are weak and spindly. The new leaves on such canes are stunted or misshapen and pale green to yellowish. This is important to remember when one considers control, because infected plants can be easily identified and removed at this time.

Within a few weeks, the lower surface of infected leaves are covered with blister-like pustules that are waxy at first but soon turn powdery and bright orange. This bright orange, rusty appearance is what gives the disease its name.

Rusted leaves wither and drop in late spring or early summer. Later in the season, the tips or infected young canes appear to have outgrown the fungus and may appear normal. At this point, infected plants are often difficult to identify.

In reality, the plants are systemically infected, and in the following years, infected canes will be bushy and spindly, and will bear little or no fruit.

For further information on this disease, including control measures, see OSU Extension Fact Sheet No. 3010-94, *Orange Rust of Brambles;* OSU Extension Bulletin 782-99, *Brambles — Production Management and Marketing;* and OSU Extension Bulletin No. 506 B2, *Ohio Commercial Small Fruit and Grape Spray Guide.*

8. BYGLOSOPHYS

Each week the *Buckeye Yard and Garden Line (BYGL)* concludes with a touch of philosophy concerning gardening or nature, human or otherwise. Here are some favorites from the 2001 BYGLs.

But each spring...a gardening instinct, sure as the sap rising in the trees, stirs within us. We look about and decide to tame another little bit of ground.

— Lewis Gantt

There is nothing pleasanter than spading when the ground is soft and damp.

— John Steinbeck

Rest is not idleness, and to lie sometimes on the grass under trees on a summer's day, listening to the murmur of the water, or watching the clouds float across the sky, is by no means a waste of time.

— J. Lubbock

Garden: One of a vast number of free outdoor restaurants operated by charity-minded amateurs in an effort to provide healthful, balanced meals for insects, birds, and animals.

— Henry Beard and Roy McKie

You can still make a small fortune in agriculture. Problem is, you have to start with a large fortune.

— Jim Hightower

No occupation is so delightful to me as the culture of the earth, and no culture comparable to that of a garden.

— Thomas Jefferson

Bread feeds the body indeed, but flowers also feed the soul.

— The Koran

The tree which moves some to tears of joy is in the eyes of others only a green thing that stands in the way. Some see Nature all ridicule and deformity, and some scarce see Nature at all. But to the eyes of the man of imagination, Nature is Imagination itself.

— William Blake

Ants are so much like human beings as to be an embarrassment. They farm fungi, raise aphids as livestock, launch armies into war, use chemical sprays to alarm and confuse enemies, capture slaves, engage in child labor, exchange information ceaselessly. They do everything but watch television.

— Lewis Thomas

When gardening, I have one gift you won't find in any manuals — I know it's strange, but I can change perennials to annuals.

— Dick Emmons

In order to live off a garden, you practically have to live in it.

— Frank McKinney Hubbard

To a gardener there is nothing more exasperating than a hose that just isn't long enough.

— Cecil Roberts

Avoid suspicion: when you're walking through your neighbor's melon patch, don't tie your shoe.

— Chinese Proverb

Water, like fire, is a good servant, perhaps, but is painfully liable to develop into a master.

— R. J. Farrer

My green thumb came only as a result of the mistakes I made while learning to see things from the plant's point of view.

— Fred Ale

Rabbits have a habit of coming for breakfast and staying for lunch. Now there's one leaf instead of a bunch.

— Gerry Krueger

It's difficult to think anything but pleasant thoughts while eating a homegrown tomato.

— Lewis Grizzard

Everybody needs beauty as well as bread, places to play in and pray in, where nature may heal and give strength to body and soul.

— John Muir

To be interested in the changing seasons is a happier state of mind than to be hopelessly in love with spring.

— George Santayana

Summary of Recommended Turfgrass Cultural Practices, Weed Control, and Disease Problems: 2001

Gary Y. Gao, Barbara Bloetscher, Joseph F. Boggs, Pamela J. Bennett, Jane C. Martin, Joseph W. Rimelspach, John R. Street, and Erik A. Draper

Summary

This article is a compilation of turfgrass tips that appeared in the weekly *Buckeye Yard and Garden Line* throughout 2001. It is a summary of recommended turfgrass cultural practices, identification, and management of turf weeds and diseases, and helpful resources.

Recommended Turfgrass Cultural Practices

Seeding

Although seeding can be done all season, fall is still preferable as the soil stays cool and moist for a longer period of time. Spring seeding can be successful as long as the soil temperatures stay cool long enough for the turfgrass seedlings to develop a good root system. Kentucky bluegrass usually germinates in 14 to 21 days and matures in six to nine months. Optimal root growth for cool season grasses, such as Kentucky bluegrass, occurs when soil temperatures are between 55ºF to 65ºF. Seedlings require a longer period of time to establish a good root system when surface soil temperatures stay cool. The root system of seedlings is proportionate to the length of the grass blades, so roots of 1" tall seedlings may only descend 1" to 2" initially.

Although tall and fine fescues germinate in one to two weeks, they require four to six months to establish a good root system that can withstand harsh conditions. Perennial ryegrass can be used throughout the summer if adequate care is provided, as it germinates in seven to 10 days and only requires two to four months to mature. However, during the hot summer months of July and August, the better option is to sod instead of seed. To minimize stress to the sod while the roots are still small and meager, limit traffic and water the turf often to cool the root zone. Monitor the development of the roots and maintain moisture to that depth. Avoid using any herbicides until the turf has been mowed at least three times. Mow high to help shade the turf crowns and maximize potential root growth.

Core Aerification

Core aerification, also referred to as aeration, is a process in which plugs of soil and

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thatch are removed from the lawn by hollow tines and deposited on top of the lawn. This procedure provides many benefits to turfgrass, especially if the grass is growing on compacted soil and/or has an excessive accumulation of thatch. The openings in the soil provide improved water infiltration and fertilizer penetration, plus turf health is improved by increased rooting and increased air in the soil. Core openings also allow oxygen to penetrate the thatch layer enhancing aerobic decomposition of this organic matter. Leaving the soil plugs on the surface speeds up the decomposition process by allowing microbes in the core to digest the thatch at the soil surface as well as below ground. Aerification also helps insecticides penetrate the thatch to reach root-feeding pests.

The process of core aerification pulls plugs, which ideally are 2" to 3" in length with a diameter of 0.50" to 0.75". At least eight to 10 plugs should be pulled per square foot. With some machines, this may mean making more than one pass over the lawn to achieve the desired number of holes.

Aerification can be done in the spring and fall. Spring is often a preferred time for core aerification since the ground is moist and better penetration is accomplished to remove deeper cores. However, preemergent herbicide should be applied afterward to reduce the potential for weed germination. Several core aerifications a year would be recommended if serious soil compaction problems exist, or a thatch layer is 0.75" or greater.

Proper Mowing Practices

Before starting to mow in the spring, make sure that the lawn mower height is properly adjusted and the blade swings freely on a level plane. Always use a sharp blade to reduce tearing and bruising of the leaf blades. Perennial ryegrass is especially susceptible to tearing during the spring mowing season. The ragged, brown leaf tips are not only unsightly but also allow moisture to escape and provide pathogens access into the leaves. Mow frequently enough to remove only 1/3 of the leaf blade at a time to avoid scalping the grass. Recommended mowing heights in spring and fall for Kentucky bluegrass, perennial ryegrass, and fine fescues are 2" to 2.5", and 2.5" to 3" for tall fescue. During summer stress periods, mowing heights for Kentucky bluegrass, perennial ryegrass, fine fescues, and tall fescue are 2.5" to 3.0".

Turf Weeds

Good cultural practices are the best defense against weed encroachment. Cultural practices, such as core aeration, proper fertilization, proper mowing practices, and mower maintenance, will produce a thicker stand of turfgrass and favor desirable turfgrass in its competition with weeds. However, where turfgrass is struggling, weeds may occur and require the use of herbicides to reduce and/or prevent heavy infestations.

Crabgrass (*Digitaria* spp.)

To prevent crabgrass and other annual grass weeds from germinating, apply a preemergent herbicide. Recommended dates for preemergent herbicide application are March 1 to April 1 for southern Ohio, March 15 to April 15 for central Ohio, and April 1 to April 25 for northern Ohio. Once soil temperatures at 2" below the surface reach 52ºF to 54ºF for several consecutive nights, crabgrass seed germinates. Since crabgrass usually begins to germinate in March or April, with the southern counties experiencing the earliest emergence, the crabgrass preventer should be applied before these dates, and may be applied as early as February.

The preemergent herbicides are primarily degraded by microbial activity. Frozen or cold soils have little microbial activity, so the product stays unaffected until the temperatures warm, and the microbes begin to digest the herbicide. Agronomists agree that it is a safe and practical approach to apply the preemergent earlier in the spring, rather than to wait and miss the target date of crabgrass germination. Irrigate the area within 48 hours after treatment to release the herbicide from the carrier. If some areas have already been seeded and a preemergent is still desired, use a product containing siduron (e.g., Tupersan.)

In early July of 2001, crabgrass grew luxuriously in the warm, wet weather and reached the three- to six-tiller stage. At that point, turf managers needed to consider whether to manage by mowing and physical removal or take a chance with herbicide application. When stressed by heat or drought, turfgrass is sensitive to herbicide injury. Similarly, absorption and uptake of herbicides decreases when temperatures are high and/or soil moisture is low. If the opportunity is present for good foliar absorption of an herbicide, quinclorac (e.g., Drive) is the herbicide of choice as it works on mature crabgrass, even in droughty situations. Quinclorac can be mixed with a preemergent herbicide such as dithiopyr (e.g., Dimension) for additional control. Both herbicides have a long list of precautions and restrictions; before using these or any other herbicides, READ THE LABEL.

Yellow Nutsedge (*Cyperus esculentus*)

Yellow nutsedge is a triangular-stemmed member of the Sedge Family (Cyperaceae). It prefers moist rich soil but will grow in most soils once established. This grasslike perennial weed spreads by means of tubers, rhizomes, and seeds. However, the main source for annual re-infestations is the tubers, which tolerate freezing temperatures and can remain viable for 10 years in the soil. Pulling up the plants simply breaks the roots from the tubers, generating additional roots, which then form new tubers. The optimal herbicide to control yellow nutsedge is halosulfuron (e.g., Manage), which can be used safely on perennial ryegrass lawns and fields, as well as on other turfgrass species. Bentazon (e.g., Basagran) and MSMA can also be used in areas infested with this weed, although turfgrass suffering from stress may become slightly discolored after an application of this herbicide. Follow label directions to avoid damaging turfgrass.

Dandelions (*Taraxacum officinale*)

During the week of April 12 in 2001, dandelions bloomed in central Ohio. Many people wanted to treat at that time. However, post-emergent herbicides would not have been effective unless conditions were conducive for the weeds to absorb and translocate the herbicide to their roots. Dandelions are best controlled when they enter the "puffball stage," when the seeds are formed. At that time, carbohydrates are sent back to the roots for storage, along with the herbicide. Although ester formulations of post-emergent herbicides work well at cooler temperatures, they are more likely than amine formulations to volatilize and injure adjacent desirable broadleaf plants at higher temperatures. If it rains within 24 hours after application, another application may be necessary if weeds show no change after two to three weeks. Delay mowing the treated area for at least three days after the treatment.

Canada Thistle (*Cirsium arvense*)

Of many herbicides labeled for Canada thistle control, clopyralid (e.g., Lontrel, Momentum) yields the best results. If possible, cut or wound the thistle, then apply the herbicide directly to the wound and leaves, being careful not to let it drift onto adjacent desirable broadleaf plants. Do not spray areas where tree/shrub roots or suckers are growing. A second option would be to use one or two applications of glyphosate (e.g., Roundup) or dicamba. Remember that dicamba is a selective herbicide, while glyphosate is non-selective and may kill the turfgrass as well as other plants contacted.

Violets (*Viola* spp.) and Other Broadleaf Weeds

Two new products containing the herbicide triclopyr are now on the market for homeowners to use on hard-to-control turfgrass weeds such as violets. This is significant because research has shown that triclopyr is the most effective chemical for controlling violets in turfgrass.

Clopyralid is very effective for controlling white clover and other hard to control weeds, such as ground ivy and buckthorn plantain. Several products for commercial use contain both clopyralid and triclopyr. These two chemicals in combination give better control of a number of weeds than either chemical by itself.

Turf Diseases

Necrotic Ring Spot (*Leptospharia korrae*)

Necrotic ring spot is a disease that causes dead rings and arcs in Kentucky bluegrass, especially when the thatch layer is dense. Although the symptoms do not show until early summer, when the turfgrass is relying heavily upon its roots for moisture, the fungus *Leptospharia korrae* becomes active in the spring when the soil is cool and moist. It attacks the crown, roots, and stems and spreads into adjacent plants, causing concentric brown patches of dead turf. Under a microscope, black runner hyphae can be found on the roots and crown area, similar to the fungi causing summer patch or take-all.

After affected turfgrass has been killed, resistant cultivars of turfgrass or weeds will gradually grow in the patch, causing a "frog-eye," a round green patch with a brown ring around it. If necrotic ring spot has plagued a lawn in the past, it would be very beneficial to aerify the soil and fertilize the turf to encourage root growth. It is also important to apply a preventive treatment of the fungicide azoxystrobin (e.g., Heritage) in late April and again in 28 days. Over-seed the area with disease-resistant cultivars of Kentucky bluegrass or a different, less susceptible species of grass, such as perennial ryegrass.

Helminthosporium Leaf Spot (*Drechslera* spp., *Bipolaris sorokiniana,* and Others)

In 2001, cool, wet conditions throughout May expedited leaf spot disease symptoms in late May on susceptible cultivars of Kentucky bluegrass. The leaf blades became spotted with small, rounded, brown to black lesions. Two fungal pathogens are usually involved with this leaf spot/melting out disease complex. *Drechslera poae* is active in the cooler, wet months of spring and fall, while *Bipolaris sorokiniana* is active from 70ºF to 98ºF. Both fungi overwinter in dead material and thatch.

Lesions caused by *Drechslera poae* appear during cooler temperatures. The fungus spreads to new leaves with splashing water. Melting out occurs at warmer temperatures as stems, crowns, and roots become necrotic. Once temperatures rise above 68ºF, *Drechslera poae* becomes dormant until cool, wet conditions return. The thinned turf may recover unless it is infected with *Bipolaris sorokiniana,* which causes spots at temperatures between 70ºF to 85ºF. As temperatures rise above 85ºF, the disease progresses to its melting out stage in which the leaf sheaths, crowns, rhizomes, and roots become blighted and leaves turn straw colored and die. The best control for these diseases is to maintain healthy turfgrass by fertilizing with fertilizer at recommended rates and using improved cultivars of grass seeds that have disease resistance.

Red Thread (*Laetisaria fuciformis*)

This disease is caused by the fungus, *Laetisaria fuciformis*, which occurs on susceptible varieties of perennial ryegrass, fine fescue, and some cultivars of Kentucky bluegrass. Under cool (50ºF to 75ºF), moist conditions, this disease produces red or pinkish "threads" of mycelium along the cut ends of the leaf blades which, when dried, stick the blades together, forming a brownish mat. As long as surface moisture is present, the disease spreads to adjacent turfgrass, causing brown, withered patches in the lawn. To reduce the severity of the disease, apply regular applications of fertilizer which contain 30% slow release nitrogen and maintain less than 1/2" of thatch. Irrigate only when the turfgrass appears drought stressed and allow leaves to dry before dusk.

Powdery Mildew (*Erysiphe graminis*)

Powdery mildew, caused by the fungus *Erysiphe graminis*, was reported on Kentucky bluegrass starting in mid May in 2001. An obligate parasite, this fungus lives on the surface of the leaf blades and inserts haustoria or suction-like mycelium into the leaf to obtain nourishment. As long as temperatures remain between 60ºF to 70ºF and humidity is high, the fungus produces copious amounts of spores, causing a white powdery look on infected blades. Although some grass blades may turn yellow and wilt, powdery mildew does not seriously damage turfgrass. Turfgrasses can be managed by pruning trees and shrubs to reduce shade and improve air circulation, and by seeding with improved cultivars resistant to powdery mildew. Fungicides are available for powdery mildew, however, they must be used preventively.

Gray Leaf Spot (*Pyricularia grisea*) Identified in Ohio

A case of gray leaf spot (*Pyricularia grisea*) was confirmed in southwestern Ohio on a perennial ryegrass fairway. Symptoms appeared as spreading patches of dark, withered leaf blades, or apparent drought stress that actually worsens when irrigated. The fungal disease is also called "blast" since it scorches the turf, making it appear as if it has been blasted with a torch.

Gray leaf spot occurs most frequently on stands of newly established perennial ryegrass during warm temperatures, when the leaves stay moist for extended periods of time. Excessive rates of fertilizer, compacted soil, and other stresses tend to exacerbate the disease.

Rhizoctonia Brown Patch (*Rhizoctonia solani* and *R. zeae*)

The sudden increase in temperatures in mid June, combined with high humidity and heavy dew, created the perfect environment for brown patch. This foliar fungal disease causes rounded, brown, or smoke-colored patches in short-cut turfgrass, but more irregular patches in high-cut Kentucky bluegrass and tall fescue. Closer examination reveals irregular dark brown lesions along a leaf margin and dry, withered blades.

Two pathogens are linked to this disease, *Rhizoctonia solani* and *R. zeae*. Symptoms appear when temperatures reach 73ºF to 85ºF and can completely blight a stand of susceptible turf in 24 hours. If *R. zeae* is present, it can continue to infect at temperatures above 90ºF. To manage this disease, water early in the day if the soil is dry, and syringe mycelium seen in the morning.

For turfgrass areas with a history of contracting brown patch, follow a preventive fungicide program.

Crown Rot Anthracnose *(Colletotrichum graminicola)*

When conditions of warmer temperatures and higher humidity occur during already stressful conditions in midsummer, crown rot anthracnose often develops on susceptible cultivars of annual bluegrass and bentgrass on golf courses. This fungal disease often begins with reddish- brown patches of turf which quickly turn to a pale yellow or tan. Turf blades may exhibit reddish brown lesions, and in later stages, black spinelike fruiting bodies.

Unfortunately, symptoms may not be noticed until infection has reached the stems, crowns, and roots. The plants may shrivel. At this point, a gentle pull on the plant may dislodge the entire plant, exposing dead roots. Although curative fungicides are available, best control occurs when treated preventively, or at least early in the infection. It is important to keep infected turf watered to avoid further stress.

Slime Molds

Slime molds became visible with the cooler, wet temperatures in late May. Tiny, gray, ball-shaped spore masses develop along the surfaces of turfgrass leaves. Although more abundant in shaded or moist areas, slime molds often appear on slow-growing turfgrass with dense thatch. These primitive fungi live on decayed or dying organic material but depend upon turfgrass and other weedy grasses for structural support.

As the spore masses dry and release the spores, the blades are covered with a dusting of purplish, gray, or white spores, causing the blades to look sooty. If the infection continues, the turf will become chlorotic and wilt, due to reduced photosynthesis. Although slime molds are not a serious threat to turfgrass, infestations can be reduced by improving air circulation and drainage and mowing the turfgrass to knock the spores back into the thatch.

Fairy Rings

Fairy rings were quite evident in some lawns in early August in 2001, particularly in the southern part of the state, where rainfall was frequent and turf was thriving. Fairy rings may be produced by any of about 50 species of soil-inhabiting fungi. Occasionally, mushrooms (fruiting bodies of the fungus involved) sprout in a ringlike pattern. The curious circular pattern of mushrooms is responsible for the common name of this disease.

Generally, the rings are lush, dark-green circles or arcs of turf growth in the lawn. Rings vary in size from 3' to 4' in diameter up to 200'. Rings can enlarge each season from a few inches to several feet in diameter, though they sometimes disappear for a year or more and then reappear.

At times, the rings may turn straw colored to brown. This "collapse" of the fairy ring may occur if conditions that favor rapid fungal growth (e.g., moist weather) are followed by a sudden stretch of dry weather. Once they dry out, the dense masses of fungal mycelial growth (fungal threads) produce hydrophobic conditions in the soil which inhibit water penetration. In fact, mycelial growth may become so dense, it resembles "cotton candy."

Control of this disease is difficult. Management strategies include improving water penetration of the area by intensive aerification or by using a hose-end root feeder, increasing spring applications of nitrogen fertilizer to mask symptoms, and removal and replacement of the soil in the infected area. Although several turf fungicides are labeled for control of fairy rings, applications may produce erratic results, and suppression of this disease is often only temporary.

A New Fungicide for Turfgrass Diseases

Medallion 50 WP, produced by Syngenta Turf and Ornamentals, is now available to manage turfgrass and many ornamental diseases. It is a protectant fungicide. Its active ingredient is fludioxonil. This is the first fungicide based on phenylpyrrole chemistry, which differs from other fungicide products on the market today.

Medallion's formulation requires lower application rates, resulting in less active ingredients (a.i.) per gallon of solution. Although re-treatment may be necessary every 14 days when the disease is active, Medallion provides good curative control of many turfgrass diseases such as brown patch, leaf spot, summer patch, and pink or gray snow mold, if used in conjunction with an integrated, preventive disease management program. It can also be mixed with other fungicides to control turfgrass diseases, depending upon label directions. Apply with sufficient water to provide good coverage and avoid damage to plants from overlap or drift.

Golf Course Superintendents' Korner

Superintendents' Korner is a web site developed by Tim Rhodus in the Department of Horticulture and Crop Science and managed by Karl Danneberger, Ohio State University turfgrass agronomist. It offers weekly updates on turfgrass culture topics occurring on golf courses in Ohio. The information is based on observations made by Karl, comments made by superintendents to him, and information obtained from other turfgrass colleagues. The topics are indexed so that inquirers can search for specific topics or scan the list of dated articles. Check it out at: *http://hcs.osu.edu/Karl/*

SportsNotes

The *SportNotes* web site was also designed by Tim Rhodus and is managed by Pam Sherratt, Ohio State sports turf specialist. *SportsNotes* was developed by the OSU Turfgrass Team to keep Ohio sports field managers abreast of current topics important in the routine management of athletic fields. Visit this site at: *http://hcs.osu.edu/sportsturf*

Please Note

Where trade names are used, no discrimination is intended and no endorsement by Ohio State University Extension is implied. Although every attempt is made to produce information that is complete, timely, and accurate, the pesticide user bears the responsibility for consulting the pesticide label and adhering to those directions.

Useful References

1. Pound, W. E. and J. Street. 1991. OSU Extension Bulletin 546. *Lawn Establishment.*

2. Street, J., W. E. Pound, D. J. Shetlar, C. C. Powell, W. W. Shane, and S. K. White. 1991. OSU Extension Bulletin 271. *Your Lawn.*

3. Boehm, M. J., W. E. Pound, J. W. Rimelspach, D. J. Shetlar, and J. R. Street. 2001. OSU Extension Bulletin L-187. *Management of Turfgrass Pests.*

4. Smiley, Richard, P. H. Dernoeden, B. B. Clarke. 1992. Second Edition. *Compendium of Turfgrass Diseases.* The American Phytopathological Society, St. Paul, Minnesota.

Biological Clocks: A Five-Year Calendar of Plant and Insect Phenology in Secrest Arboretum

Daniel A. Herms

Summary

The tremendous diversity of ornamental plants, each with its own complement of insect pests, creates a logistical challenge for planning and implementing successful pest-management programs for nurseries and landscapes. Many insects are difficult to detect and monitor, further complicating the accurate timing of pesticide applications. Variation in weather patterns from year-to-year can make calendar-based scheduling inaccurate. The use of plant phenology provides an alternative approach for predicting insect activity and timing pest-management tactics. Because the development of both plants and insects is temperature dependent, plants accurately track degree-day accumulation and insect development.

This report presents a five-year phenological sequence for 92 plant and 43 insect and mite taxa for Secrest Arboretum in Wooster, Ohio, from 1997-2001. Despite substantial variation in weather patterns during these five years, the order in which the phenological events occurred was quite consistent, with only minor deviations from year-to-year. This consistency in the pattern demonstrates that even one year of phenological data can be useful for timing pest management decisions. To facilitate phenological monitoring by landscape and nursery managers, a column is included on the phenological calendar for recording phenological observations so that the table can be copied and used as a data sheet for monitoring plant and pest development.

Introduction

Planning and implementing a successful pest-management program for landscapes constitutes a logistical challenge because of the tremendous diversity of ornamental plants, each with its own complement of insect pests. Insecticide applications must be timed precisely to maximize their effectiveness and minimize the number required. This is especially true of the environmentally friendly but short-lived "biorational" insecticides such as horticultural oils and soaps, and for insects such as scales and borers that are only susceptible during specific stages. Many insects are difficult to detect and monitor, further complicating the accurate timing of pesticide applications. Consequently, pesticide applications are frequently scheduled on a calendar-day basis. However, because of variation in patterns of degree-day accumulation from place-to-place and year-to-year, calendar-based scheduling is frequently inaccurate.

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The use of plant phenology provides an alternative approach for predicting insect activity. Phenology is the study of recurring biological phenomena and their relationship to weather. Bird migration, hunting and gathering seasons, blooming of wildflowers and trees, and the seasonal appearance of insects are examples of phenological events that have been recorded for centuries (Glendenning, 1943; Levitt, 1981).

Because the development of both plants (Rathcke and Lacey, 1985) and insects (Tauber and Tauber, 1981) is temperature dependent, plants accurately track degree-day accumulation and insect development. Indeed, the use of plant phenology to predict insect activity is an old practice, with recorded observations dating back at least to the 18th century (Huberman, 1941). Recent studies have shown that the phenology of many birds, plants, and insects has been altered over the last 50 years in response to global warming (Bradley, et al. 1999; Menzel and Fabian, 1999; Peñueles and Filella, 2001).

The critical assumption in the use of plant phenology to predict pest activity is that the phenological sequence (the order in which phenological events occur) remains constant from year-to-year even when weather patterns differ greatly. A comparison of phenological patterns in the Secrest Arboretum at the Ohio Agricultural Research and Development Center in Wooster from 1997-2001 provides an ideal opportunity for testing this assumption. Weather patterns varied substantially over this period. Spring 1997 was delayed and cool, while 1998, the year of *El Niño*, was characterized by an early warm spring, and the springs of 1999, 2000, and 2001 were intermediate.

Methods and Materials

During 1997, the phenology of 56 plant species and/or cultivars and 22 species of insects were monitored. From 1998-2001, this list was expanded to 92 plant and 43 insect and mite taxa. Four individuals of each plant species or cultivar were monitored. To control for microenvironmental variation, all individuals of a particular taxon were located either in uniform sun or shade, depending on the environment to which the species is best adapted. Plants in microenvironments obviously altered by buildings, parking lots, bodies of water, and other such factors were not included.

Plants were monitored at least three times each week, with the dates of "first bloom" and "full bloom" recorded. "First bloom" is defined as the date on which the first flower bud on the plant opens, revealing pistils and/or stamens, and "full bloom" as the date on which 95% of the flower buds have opened (i.e., one bud out of 20 has yet to open). These phenological events can be identified and recorded with precision.

The insect and mite species monitored in this study represent diverse life histories and include defoliators, wood borers, scales and other sucking insects, gall formers, leafminers, and spider mites. In contrast to methods used to monitor plant phenology, which were designed to minimize variation in order to increase predictive power, sampling protocols for insects were designed to characterize the phenology of the entire population.

Degree-days were calculated using the double sine wave method (Allen 1976) from daily maximum and minimum temperature data for Wooster (OARDC Weather System, Wooster Station), using a base temperature of 50ºF (DD50) and a starting date of January 1. For more detail regarding the calculation and use of degree-days, see Herms 1999 and 2001.

Results and Discussion

The phenological sequence from 1997-2001 is presented in Table 1. For clarity, only common names are listed. To achieve standardization, for common names of plants follow Dirr (1998), and for insect and mite names use the official common names as approved by the Entomological Society of America.

In general, plant and insect phenology was delayed during the cool spring of 1997 and accelerated in the warm spring of 1998, relative to the more "average" years of 1999-2001. Despite these differences in weather, the order in which the phenological events occurred remained quite consistent, with only minor deviations from year-to-year.

This consistency in the pattern demonstrates that even one year of phenological data can be useful for timing pest management decisions. For example, a pest control operator could note what plants happened to be in bloom when a pesticide application was made. If follow-up monitoring showed the application to be effective, then the timing of the spray could be accurately duplicated the following season. If the application was found to be too early or too late, then the timing of the application in future years could be delayed or accelerated relative to the phenological sequence. To facilitate phenological monitoring by landscape and nursery managers, a column for recording data has been included in Table 1 so that the table can be copied for use as a data sheet.

Literature Cited

Allen, J. C. 1976. A modified sine wave method for calculating degree-days. *Environmental Entomology* 5:388-396.

Bradley, N. L., A. C. Leopold, J. Ross, and W. Huffaker. 1999. Phenological changes reflect climate change in Wisconsin. Proceedings, National Academy of Science 96:9701-9704.

Dirr, M. A. 1998. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses. 5th Edition. Stipes Publishing Co., Champaign, Illinois.

Glendenning, R. 1943. Phenology: the most natural of sciences. *Canadian Field-Naturalist* 57:75-78.

Herms, D. A. 1999. Understanding and using degree-days. In: M. A. Rose and J. A. Chatfield, Eds. *Ornamental Plants: Annual Reports and Research Reviews, 1998.* pp. 70-76. The Ohio State University. Ohio Agricultural Research and Development Center. Special Circular 165, 136 pp.

Herms, D. A. 2001. Degrees of separation: using degree-days and observing blooming times to predict when insect pests emerge. *American Nurseryman* 194(4):34-40.

Huberman, M. A. 1941. Why phenology? *Journal of Forestry* 39:1007-1013.

Levitt, D. 1981. Aboriginal uses of plants. Groote Eylandt. Australian Institute of Aboriginal Studies, Canberra, Australia.

Menzel, A. and P. Fabian. 1999. Growing season extended in Europe. *Nature* 397:659.

Peñueles, J. and I. Filella. 2001. Perspectives on phenology: responses to a warming world. *Science* 294:793-794.

Rathcke, B. and E. L. Lacey. 1985. Phenological patterns of terrestrial plants. *Annual Review of Ecology and Systematics* 16:179-214.

Tauber, C. A. and M. J. Tauber. 1981. Insect seasonal cycles: genetics and evolution. *Annual Review of Ecology and Systematics* 12:281-308.

Table 1. A Phenological Sequence for Wooster, Ohio, from 1997-2001.

Includes Date of Occurrence and Cumulative Degree-Days (DD50) for 92 Plant and 43 Insect and Mite Taxa in Secrest Arboretum. Insect and mite species are indicated in bold (NA indicates no data are available). Cumulative degree-days (DD50) were calculated using a base temperature of 50°F and a starting date of January 1. A column has been included for the current year's date so that readers may use this table as a data sheet for monitoring plant and pest activity.

Plant or Arthropod Taxon	Phenological Event	Year					Average		Current Year's
		1997	1998	1999	2000	2001	Date	DD50	Date
Silver Maple	first bloom	7-Mar	25-Feb	3-Mar	27-Feb	7-Mar	2-Mar	34	
Corneliancherry Dogwood	first bloom	15-Mar	10-Mar	19-Mar	5-Mar	31-Mar	16-Mar	40	
Silver Maple	full bloom	25-Mar	15-Mar	28-Mar	4-Mar	23-Mar	19-Mar	42	
Speckled Alder	first bloom	13-Mar	27-Mar	27-Mar	7-Mar	6-Apr	22-Mar	52	
Red Maple	first bloom	25-Mar	23-Mar	29-Mar	6-Mar	3-Apr	24-Mar	44	
Speckled Alder	full bloom	22-Mar	31-Mar	4-Apr	15-Mar	NA	25-Mar	97	
Northern Lights Forsythia	first bloom	30-Mar	25-Mar	1-Apr	8-Mar	4-Apr	26-Mar	58	
Japanese Pieris	first bloom	NA	25-Mar	30-Mar	14-Mar	7-Apr	27-Mar	60	
Red Maple	full bloom	4-Apr	28-Mar	1-Apr	9-Mar	6-Apr	28-Mar	75	
Manchu Cherry	first bloom	2-Apr	28-Mar	4-Apr	22-Mar	NA	29-Mar	93	
Border Forsythia	first bloom	30-Mar	28-Mar	3-Apr	19-Mar	8-Apr	30-Mar	86	
Star Magnolia	first bloom	4-Apr	28-Mar	2-Apr	23-Mar	7-Apr	31-Mar	83	
Northern Lights Forsythia	full bloom	4-Apr	29-Mar	7-Apr	17-Mar	8-Apr	31-Mar	94	
Eastern Tent Caterpillar	**egg hatch**	**4-Apr**	**28-Mar**	**4-Apr**	**23-Mar**	**8-Apr**	**1-Apr**	**92**	
Corneliancherry Dogwood	full bloom	4-Apr	28-Mar	4-Apr	25-Mar	9-Apr	1-Apr	98	
Norway Maple	first bloom	6-Apr	30-Mar	7-Apr	25-Mar	10-Apr	3-Apr	116	
Border Forsythia	full bloom	4-Apr	30-Mar	10-Apr	26-Mar	11-Apr	4-Apr	116	
Chanticleer Callery Pear	first bloom	7-Apr	30-Mar	8-Apr	25-Mar	11-Apr	4-Apr	123	
Sargent Cherry	first bloom	5-Apr	31-Mar	11-Apr	25-Mar	11-Apr	4-Apr	127	
Saucer Magnolia	first bloom	NA	8-Apr	5-Apr	28-Mar	12-Apr	5-Apr	133	
Larch Casebearer	**egg hatch**	**15-Apr**	**6-Apr**	**8-Apr**	**25-Mar**	**10-Apr**	**6-Apr**	**128**	
Japanese Pieris	full bloom	NA	29-Mar	11-Apr	9-Apr	11-Apr	7-Apr	129	
Common Floweringquince	first bloom	23-Apr	1-Apr	8-Apr	26-Mar	12-Apr	8-Apr	137	
Manchu Cherry	full bloom	NA	2-Apr	15-Apr	7-Apr	NA	8-Apr	155	
Bradford Callery Pear	first bloom	21-Apr	1-Apr	11-Apr	31-Mar	14-Apr	9-Apr	142	
Weeping Higan Cherry	first bloom	20-Apr	1-Apr	13-Apr	3-Apr	13-Apr	10-Apr	145	
European Pine Sawfly	**egg hatch**	**15-Apr**	**6-Apr**	**11-Apr**	**1-Apr**	**18-Apr**	**10-Apr**	**144**	
Sargent Cherry	full bloom	NA	1-Apr	20-Apr	6-Apr	13-Apr	10-Apr	151	
Norway Maple	full bloom	NA	31-Mar	14-Apr	13-Apr	16-Apr	11-Apr	149	
Inkberry Leafminer	**adult emergence**	**15-Apr**	**10-Apr**	**13-Apr**	**6-Apr**	**14-Apr**	**11-Apr**	**150**	
PJM Rhododendron	first bloom	21-Apr	1-Apr	10-Apr	10-Apr	15-Apr	11-Apr	147	
Star Magnolia	full bloom	NA	NA	17-Apr	2-Apr	16-Apr	11-Apr	151	
Spruce Spider Mite	**egg hatch**	**NA**	**20-Apr**	**16-Apr**	**5-Apr**	**11-Apr**	**13-Apr**	**162**	
Chanticleer Callery Pear	full bloom	20-Apr	1-Apr	18-Apr	7-Apr	19-Apr	13-Apr	149	
Bradford Callery Pear	full bloom	NA	7-Apr	19-Apr	12-Apr	22-Apr	15-Apr	164	
Allegheny Serviceberry	first bloom	23-Apr	7-Apr	19-Apr	12-Apr	19-Apr	16-Apr	153	
Spring Snow Crabapple	first bloom	22-Apr	6-Apr	21-Apr	14-Apr	18-Apr	16-Apr	155	
Apple Serviceberry	first bloom	22-Apr	8-Apr	20-Apr	14-Apr	21-Apr	17-Apr	159	
Boxwood Psyllid	**egg hatch**	**NA**	**15-Apr**	**19-Apr**	**20-Apr**	**14-Apr**	**17-Apr**	**179**	
Compact Garland Spirea	first bloom	27-Apr	8-Apr	20-Apr	14-Apr	19-Apr	17-Apr	159	
Saucer Magnolia	full bloom	NA	NA	18-Apr	15-Apr	22-Apr	18-Apr	174	
Allegheny Serviceberry	full bloom	29-Apr	9-Apr	24-Apr	14-Apr	21-Apr	19-Apr	169	
PJM Rhododendron	full bloom	1-May	8-Apr	19-Apr	17-Apr	22-Apr	19-Apr	178	
Weeping Higan Cherry	full bloom	29-Apr	11-Apr	24-Apr	16-Apr	22-Apr	20-Apr	179	

Table 1 (continued). A Phenological Sequence for Wooster, Ohio, from 1997-2001.

Plant or Arthropod Taxon	Phenological Event	Year					Average		Current Year's
		1997	1998	1999	2000	2001	Date	DD50	Date
Apple Serviceberry	full bloom	29-Apr	11-Apr	25-Apr	19-Apr	22-Apr	21-Apr	182	________
Koreanspice Viburnum	first bloom	26-Apr	13-Apr	28-Apr	17-Apr	22-Apr	21-Apr	185	________
Common Chokecherry	first bloom	2-May	16-Apr	25-Apr	15-Apr	20-Apr	21-Apr	182	________
Regent Serviceberry	first bloom	1-May	13-Apr	26-Apr	16-Apr	22-Apr	22-Apr	186	________
Japanese Flowering Crab	first bloom	5-May	14-Apr	23-Apr	16-Apr	22-Apr	22-Apr	189	________
Gypsy Moth	**egg hatch**	**7-May**	**16-Apr**	**26-Apr**	**16-Apr**	**21-Apr**	**23-Apr**	**192**	________
Azalea Lace Bug	**egg hatch**	**NA**	**NA**	**20-Apr**	**20-Apr**	**30-Apr**	**23-Apr**	**206**	________
Eastern Redbud	first bloom	7-May	14-Apr	26-Apr	17-Apr	21-Apr	23-Apr	191	________
Donald Wyman Crabapple	first bloom	4-May	16-Apr	27-Apr	17-Apr	22-Apr	23-Apr	197	________
Snowdrift Crabapple	first bloom	2-May	17-Apr	28-Apr	17-Apr	22-Apr	23-Apr	198	________
Compact Garland Spirea	full bloom	6-May	16-Apr	27-Apr	20-Apr	23-Apr	24-Apr	205	________
Elm Leafminer	**adult emergence**	**NA**	**22-Apr**	**26-Apr**	**23-Apr**	**27-Apr**	**24-Apr**	**219**	________
Koreanspice Viburnum	full bloom	7-May	17-Apr	17-Apr	25-Apr	26-Apr	24-Apr	205	________
Spring Snow Crabapple	full bloom	3-May	17-Apr	27-Apr	22-Apr	26-Apr	25-Apr	209	________
Alder Leafminer	**adult emergence**	**NA**	**25-Apr**	**26-Apr**	**23-Apr**	**27-Apr**	**25-Apr**	**224**	________
Carolina Silverbell	first bloom	5-May	18-Apr	28-Apr	22-Apr	25-Apr	25-Apr	213	________
Birch Leafminer	**adult emergence**	**5-May**	**22-Apr**	**26-Apr**	**24-Apr**	**27-Apr**	**26-Apr**	**215**	________
Common Floweringquince	full bloom	22-May	13-Apr	25-Apr	21-Apr	23-Apr	27-Apr	214	________
Coral Burst Crabapple	first bloom	11-May	18-Apr	29-Apr	21-Apr	26-Apr	27-Apr	217	________
Honeylocust Spider Mite	**egg hatch**	**NA**	**NA**	**28-Apr**	**28-Apr**	**27-Apr**	**27-Apr**	**227**	________
Regent Serviceberry	full bloom	7-May	21-Apr	30-Apr	23-Apr	26-Apr	27-Apr	219	________
Common Chokecherry	full bloom	8-May	21-Apr	1-May	24-Apr	26-Apr	28-Apr	221	________
Hawthorn Lace Bug	**adult emergence**	**NA**	**22-Apr**	**3-May**	**4-May**	**29-Apr**	**29-Apr**	**253**	________
Sargent Crabapple	first bloom	10-May	24-Apr	2-May	23-Apr	28-Apr	29-Apr	230	________
Wayfaringtree Viburnum	first bloom	10-May	22-Apr	2-May	24-Apr	29-Apr	29-Apr	229	________
Tatarian Honeysuckle	first bloom	12-May	23-Apr	2-May	23-Apr	30-Apr	30-Apr	233	________
Honeylocust Plant Bug	**egg hatch**	**16-May**	**22-Apr**	**28-Apr**	**28-Apr**	**29-Apr**	**30-Apr**	**230**	________
Common Lilac	first bloom	15-May	23-Apr	1-May	26-Apr	29-Apr	1-May	234	________
Hawthorn Leafminer	**adult emergence**	**NA**	**NA**	**NA**	**3-May**	**30-Apr**	**1-May**	**260**	________
Persian Lilac	first bloom	16-May	23-Apr	2-May	28-Apr	30-Apr	1-May	240	________
Ohio Buckeye	first bloom	14-May	26-Apr	2-May	2-May	27-Apr	2-May	245	________
Eastern Redbud	full bloom	19-May	27-Apr	2-May	28-Apr	26-Apr	2-May	245	________
Snowdrift Crabapple	full bloom	15-May	24-Apr	4-May	29-Apr	1-May	2-May	250	________
Donald Wyman Crabapple	full bloom	16-May	26-Apr	3-May	30-Apr	1-May	3-May	251	________
Japanese Flowering Crab	full bloom	22-May	23-Apr	2-May	30-Apr	1-May	3-May	254	________
Common Horsechestnut	first bloom	16-May	27-Apr	2-May	4-May	29-Apr	4-May	251	________
Imported Willow Leaf Beetle	**adult emergence**	**18-May**	**24-Apr**	**5-May**	**5-May**	**3-May**	**5-May**	**274**	________
Flowering Dogwood	first bloom	20-May	26-Apr	4-May	4-May	1-May	5-May	263	________
Coral Burst Crabapple	full bloom	18-May	29-Apr	3-May	4-May	1-May	5-May	263	________
Dwarf Fothergilla	first bloom	20-May	30-Apr	5-May	4-May	27-Apr	5-May	265	________
Carolina Silverbell	full bloom	17-May	30-Apr	3-May	3-May	3-May	5-May	266	________
Red Buckeye	first bloom	18-May	30-Apr	4-May	3-May	1-May	5-May	265	________
Japanese Kerria	first bloom	20-May	30-Apr	4-May	4-May	1-May	5-May	268	________
Blackhaw Viburnum	first bloom	19-May	29-Apr	4-May	3-May	2-May	6-May	269	________
Red Chokeberry	first bloom	19-May	29-Apr	6-May	4-May	3-May	6-May	281	________
Wayfaringtree Viburnum	full bloom	20-May	1-May	6-May	5-May	3-May	7-May	290	________
Sargent Crabapple	full bloom	19-May	2-May	6-May	6-May	4-May	7-May	298	________
Red Horsechestnut	first bloom	19-May	2-May	6-May	6-May	6-May	7-May	304	________
Pine Needle Scale	**egg hatch - 1st generation**	**22-May**	**3-May**	**5-May**	**6-May**	**6-May**	**8-May**	**305**	________
Persian Lilac	full bloom	23-May	4-May	7-May	3-May	6-May	8-May	303	________

Table 1 (continued). A Phenological Sequence for Wooster, Ohio, from 1997-2001.

Plant or Arthropod Taxon	Phenological Event	Year 1997	1998	1999	2000	2001	Average Date	DD50	Current Year's Date
Cooley Spruce Gall Adelgid	**egg hatch**	**22-May**	**3-May**	**6-May**	**6-May**	**6-May**	**8-May**	**308**	
Eastern Spruce Gall Adelgid	**egg hatch**	**22-May**	**3-May**	**6-May**	**6-May**	**6-May**	**8-May**	**308**	
Pink Princess Weigela	first bloom	20-May	1-May	9-May	7-May	6-May	8-May	316	
Umbrella Magnolia	first bloom	26-May	4-May	6-May	5-May	3-May	9-May	304	
Vanhoutte Spirea	first bloom	25-May	4-May	7-May	4-May	5-May	9-May	309	
Common Lilac	full bloom	26-May	3-May	7-May	6-May	5-May	9-May	315	
Blackhaw Viburnum	full bloom	22-May	4-May	9-May	7-May	6-May	9-May	322	
Redosier Dogwood	first bloom	27-May	5-May	8-May	6-May	5-May	10-May	323	
Winter King Hawthorn	first bloom	26-May	6-May	10-May	6-May	5-May	10-May	328	
Lilac Borer	**adult emergence**	**30-May**	**5-May**	**10-May**	**7-May**	**3-May**	**11-May**	**330**	
Dwarf Fothergilla	full bloom	23-May	NA	9-May	7-May	6-May	11-May	325	
Slender Deutsia	first bloom	29-May	6-May	9-May	7-May	6-May	11-May	338	
Common Horsechestnut	full bloom	29-May	5-May	10-May	8-May	7-May	12-May	344	
Red Chokeberry	full bloom	26-May	8-May	11-May	8-May	7-May	12-May	351	
Doublefile Viburnum	first bloom	27-May	7-May	12-May	7-May	9-May	12-May	353	
Pagoda Dogwood	first bloom	30-May	7-May	11-May	9-May	8-May	13-May	363	
Red Java Weigela	first bloom	29-May	6-May	11-May	9-May	11-May	13-May	365	
Black Cherry	first bloom	28-May	9-May	12-May	9-May	8-May	13-May	368	
Holly Leafminer	**adult emergence**	**29-May**	**9-May**	**11-May**	**9-May**	**11-May**	**13-May**	**375**	
Japanese Kerria	full bloom	23-May	NA	9-May	10-May	NA	14-May	342	
Lesser Peach Tree Borer	**adult emergence**	**4-Jun**	**6-May**	**10-May**	**8-May**	**11-May**	**14-May**	**372**	
Ohio Buckeye	full bloom	31-May	8-May	12-May	10-May	8-May	14-May	374	
Common Sweetshrub	first bloom	4-Jun	11-May	12-May	8-May	5-May	14-May	371	
Locust Leafminer	**adult emergence**	**NA**	**NA**	**NA**	**NA**	**16-May**	**16-May**	**437**	
Euonymus Scale	**egg hatch - 1st generation**	**30-May**	**15-May**	**15-May**	**10-May**	**11-May**	**16-May**	**406**	
Ohio Pioneer Thicket Hawthorn	first bloom	26-May	6-May	20-May	16-May	16-May	16-May	406	
Vanhoutte Spirea	full bloom	1-Jun	12-May	17-May	9-May	14-May	16-May	406	
Winter King Hawthorn	full bloom	5-Jun	11-May	14-May	10-May	14-May	17-May	407	
Tatarian Honeysuckle	full bloom	28-May	12-May	17-May	15-May	12-May	17-May	410	
Catawba Rhododendron	first bloom	2-Jun	9-May	15-May	13-May	15-May	17-May	407	
Beautybush	first bloom	3-Jun	11-May	17-May	12-May	13-May	17-May	417	
Black Cherry	full bloom	3-Jun	13-May	15-May	13-May	13-May	18-May	419	
Miss Kim Manchurian Lilac	first bloom	4-Jun	12-May	19-May	11-May	14-May	18-May	422	
White Fringetree	first bloom	9-Jun	14-May	16-May	12-May	12-May	19-May	435	
Snowmound Nippon Spirea	first bloom	9-Jun	16-May	16-May	13-May	12-May	19-May	445	
Red Prince Weigela	first bloom	3-Jun	15-May	21-May	14-May	13-May	19-May	446	
Pink Princess Weigela	full bloom	2-Jun	16-May	19-May	13-May	16-May	19-May	446	
Doublefile Viburnum	full bloom	1-Jun	15-May	18-May	15-May	18-May	20-May	444	
Bush Cinquefoil	first bloom	8-Jun	14-May	18-May	12-May	16-May	20-May	444	
Redosier Dogwood	full bloom	5-Jun	15-May	19-May	14-May	15-May	20-May	448	
Red Horsechestnut	full bloom	2-Jun	13-May	16-May	19-May	18-May	20-May	440	
Black Locust	first bloom	9-Jun	17-May	18-May	14-May	17-May	21-May	467	
Scarlet Firethorn	first bloom	1-Jun	10-May	23-May	18-May	22-May	21-May	459	
Red Buckeye	full bloom	7-Jun	17-May	18-May	15-May	20-May	21-May	471	
Umbrella Magnolia	full bloom	9-Jun	18-May	24-May	15-May	14-May	22-May	480	

Table 1 (continued). A Phenological Sequence for Wooster, Ohio, from 1997-2001.

Plant or Arthropod Taxon	Phenological Event	Year 1997	1998	1999	2000	2001	Average Date	DD50	Current Year's Date
Common Ninebark	first bloom	9-Jun	16-May	21-May	17-May	18-May	22-May	478	________
Sweet Mockorange	first bloom	8-Jun	17-May	22-May	16-May	19-May	22-May	482	________
Pagoda Dogwood	full bloom	9-Jun	15-May	26-May	17-May	17-May	23-May	479	________
Ohio Pioneer Thicket Hawthorn	full bloom	5-Jun	11-May	26-May	23-May	24-May	24-May	470	________
Oystershell Scale	**egg hatch**	**9-Jun**	**17-May**	**27-May**	**18-May**	**19-May**	**24-May**	**497**	________
Smokebush	first bloom	12-Jun	19-May	22-May	17-May	19-May	24-May	501	________
Miss Kim Manchurian Lilac	full bloom	9-Jun	15-May	26-May	20-May	22-May	24-May	498	________
White Fringetree	full bloom	13-Jun	17-May	23-May	18-May	22-May	25-May	517	________
Catawba Rhododendron	full bloom	10-Jun	15-May	26-May	22-May	22-May	25-May	503	________
Arrowwood Viburnum	first bloom	12-Jun	18-May	27-May	23-May	25-May	27-May	534	________
American Yellowwood	first bloom	13-Jun	23-May	23-May	24-May	23-May	27-May	546	________
Black Locust	full bloom	14-Jun	21-May	27-May	21-May	25-May	27-May	548	________
Sweetbay Magnolia	first bloom	22-Jun	23-May	20-May	26-May	17-May	27-May	566	________
Bronze Birch Borer	**adult emergence**	**12-Jun**	**18-May**	**2-Jun**	**23-May**	**23-May**	**28-May**	**547**	________
Multiflora Rose	first bloom	14-Jun	18-May	28-May	26-May	25-May	28-May	548	________
American Holly	first bloom	13-Jun	20-May	26-May	28-May	24-May	28-May	556	________
American Yellowwood	full bloom	NA	26-May	27-May	30-May	1-Jun	28-May	599	________
Red Java Weigela	full bloom	14-Jun	17-May	3-Jun	25-May	24-May	29-May	565	________
Potato Leafhopper	**adult arrival**	**16-Jun**	**22-May**	**27-May**	**29-May**	**21-May**	**29-May**	**568**	________
Juniper Scale	**egg hatch**	**14-Jun**	**21-May**	**1-Jun**	**19-May**	**29-May**	**29-May**	**571**	________
Black Vine Weevil	**adult emergence**	**NA**	**31-May**	**10-Jun**	**28-May**	**22-May**	**30-May**	**677**	________
Mountain-laurel	first bloom	12-Jun	20-May	28-May	26-May	2-Jun	30-May	565	________
Scarlet Firethorn	full bloom	8-Jun	18-May	1-Jun	27-May	5-Jun	30-May	565	________
Snowmound Nippon Spirea	full bloom	14-Jun	20-May	2-Jun	22-May	3-Jun	31-May	583	________
Beautybush	full bloom	17-Jun	19-May	31-May	27-May	3-Jun	31-May	592	________
Common Ninebark	full bloom	15-Jun	21-May	1-Jun	26-May	4-Jun	1-Jun	596	________
Chinese Dogwood	first bloom	15-Jun	23-May	30-May	28-May	4-Jun	1-Jun	593	________
Smokebush	full bloom	17-Jun	22-May	1-Jun	28-May	5-Jun	2-Jun	611	
Japanese Tree Lilac	first bloom	21-Jun	23-May	31-May	27-May	3-Jun	2-Jun	622	________
Arrowwood Viburnum	full bloom	17-Jun	24-May	2-Jun	30-May	4-Jun	3-Jun	621	________
Washington Hawthorn	first bloom	20-Jun	26-May	2-Jun	30-May	2-Jun	3-Jun	635	________
Bumald Spirea	first bloom	14-Jun	27-May	2-Jun	31-May	5-Jun	3-Jun	624	________
American Holly	full bloom	19-Jun	26-May	2-Jun	3-Jun	31-May	4-Jun	642	________
Multiflora Rose	full bloom	18-Jun	24-May	2-Jun	2-Jun	8-Jun	4-Jun	643	________
Greater Peach Tree Borer	**adult emergence**	**NA**	**12-Jun**	**2-Jun**	**1-Jun**	**5-Jun**	**5-Jun**	**702**	________
Fuzzy Deutzia	first bloom	NA	7-Jun	8-Jun	2-Jun	6-Jun	6-Jun	727	________
Calico Scale	**egg hatch**	**NA**	**30-May**	**8-Jun**	**4-Jun**	**14-Jun**	**6-Jun**	**748**	________
Northern Catalpa	first bloom	22-Jun	28-May	2-Jun	1-Jun	9-Jun	6-Jun	675	________
European Fruit Lecanium Scale	**egg hatch**	**NA**	**1-Jun**	**8-Jun**	**8-Jun**	**14-Jun**	**7-Jun**	**767**	________
Sweet Mockorange	full bloom	24-Jun	29-May	7-Jun	1-Jun	11-Jun	8-Jun	717	________
Striped Pine Scale	**egg hatch**	**NA**	**4-Jun**	**10-Jun**	**6-Jun**	**14-Jun**	**8-Jun**	**783**	________
American Elder	first bloom	22-Jun	28-May	7-Jun	5-Jun	10-Jun	8-Jun	707	________
Red Prince Weigela	full bloom	20-Jun	25-May	13-Jun	6-Jun	11-Jun	8-Jun	727	________
Washington Hawthorn	full bloom	24-Jun	31-May	8-Jun	3-Jun	9-Jun	9-Jun	731	________
Winterberry Holly	first bloom	NA	3-Jun	10-Jun	9-Jun	14-Jun	9-Jun	794	________
Rhododendron Borer	**adult emergence**	**NA**	**6-Jun**	**8-Jun**	**11-Jun**	**17-Jun**	**10-Jun**	**815**	________
Dogwood Borer	**adult emergence**	**NA**	**31-May**	**9-Jun**	**6-Jun**	**28-Jun**	**10-Jun**	**830**	________
Oakleaf Hydrangea	first bloom	NA	9-Jun	11-Jun	10-Jun	17-Jun	12-Jun	835	________

Table 1 (continued). A Phenological Sequence for Wooster, Ohio, from 1997-2001.

Plant or Arthropod Taxon	Phenological Event	Year 1997	1998	1999	2000	2001	Average Date	DD50	Current Year's Date
Cottony Maple Scale	**egg hatch**	**NA**	**14-Jun**	**12-Jun**	**8-Jun**	**17-Jun**	**12-Jun**	**851**	
Panicle Hydrangea	first bloom	NA	NA	12-Jun	11-Jun	16-Jun	13-Jun	856	
Japanese Tree Lilac	full bloom	28-Jun	4-Jun	10-Jun	9-Jun	14-Jun	13-Jun	808	
Mimosa Webworm	**egg hatch - 1st generation**	**NA**	**12-Jun**	**10-Jun**	**16-Jun**	**16-Jun**	**13-Jun**	**874**	
Northern Catalpa	full bloom	25-Jun	6-Jun	9-Jun	11-Jun	17-Jun	13-Jun	816	
Winged Euonymus Scale	**egg hatch**	**NA**	**12-Jun**	**13-Jun**	**12-Jun**	**20-Jun**	**14-Jun**	**892**	
Fuzzy Deutzia	full bloom	NA	13-Jun	16-Jun	14-Jun	14-Jun	14-Jun	884	
Mountain-laurel	full bloom	25-Jun	8-Jun	12-Jun	10-Jun	15-Jun	14-Jun	822	
Winterberry Holly	full bloom	NA	13-Jun	13-Jun	14-Jun	18-Jun	14-Jun	897	
Southern Catalpa	first bloom	NA	14-Jun	13-Jun	15-Jun	19-Jun	15-Jun	913	
Fall Webworm	**egg hatch**	**24-Jun**	**12-Jun**	**19-Jun**	**13-Jun**	**16-Jun**	**16-Jun**	**867**	
Spruce Budscale	**egg hatch**	**30-Jun**	**12-Jun**	**12-Jun**	**12-Jun**	**21-Jun**	**17-Jun**	**894**	
Azalea Bark Scale	**egg hatch**	**NA**	**17-Jun**	**19-Jun**	**16-Jun**	**20-Jun**	**18-Jun**	**957**	
Greenspire Littleleaf Linden	first bloom	30-Jun	12-Jun	11-Jun	20-Jun	16-Jun	18-Jun	899	
June Bride Littleleaf Linden	first bloom	NA	NA	20-Jun	17-Jun	18-Jun	18-Jun	953	
Bumald Spirea	full bloom	2-Jul	19-Jun	11-Jun	11-Jun	20-Jun	18-Jun	917	
American Elder	full bloom	28-Jun	12-Jun	17-Jun	16-Jun	19-Jun	18-Jun	909	
Panicled Goldenraintree	first bloom	7-Jul	15-Jun	12-Jun	14-Jun	17-Jun	19-Jun	924	
Japanese Beetle	**adult emergence**	**2-Jul**	**17-Jun**	**19-Jun**	**19-Jun**	**21-Jun**	**21-Jun**	**970**	
Southern Catalpa	full bloom	NA	23-Jun	21-Jun	23-Jun	28-Jun	23-Jun	1073	
Rosebay Rhododendron	first bloom	7-Jul	17-Jun	26-Jun	16-Jun	22-Jun	24-Jun	1010	
Greenspire Littleleaf Linden	full bloom	6-Jul	23-Jun	16-Jun	27-Jun	22-Jun	24-Jun	1047	
June Bride Littleleaf Linden	full bloom	NA	NA	26-Jun	25-Jun	28-Jun	26-Jun	1115	
Bottlebrush Buckeye	first bloom	NA	23-Jun	27-Jun	29-Jun	1-Jul	27-Jun	1158	
Ural Falsespirea	first bloom	NA	NA	2-Jul	26-Jun	28-Jun	28-Jun	1170	
Panicled Goldenraintree	full bloom	28-Jul	23-Jun	27-Jun	1-Jul	7-Jul	5-Jul	1251	
Pine Needle Scale	**egg hatch - 2nd generation**	**NA**	**30-Jun**	**5-Jul**	**7-Jul**	**15-Jul**	**6-Jul**	**1349**	
Rose-of-Sharon	first bloom	NA	NA	2-Jul	11-Jul	12-Jul	8-Jul	1347	
Euonymus Scale	**egg hatch - 2nd generation**	**NA**	**30-Jul**	**23-Jul**	**25-Jul**	**26-Jul**	**26-Jul**	**1923**	
Magnolia Scale	**egg hatch**	**3-Aug**	**7-Aug**	**2-Aug**	**8-Aug**	**3-Aug**	**4-Aug**	**1938**	
Banded Ash Clearwing Borer	**adult emergence**	**NA**	**NA**	**13-Aug**	**17-Aug**	**13-Aug**	**14-Aug**	**2195**	

Progress in Research on Systemic Induced Resistance in Austrian Pine Against Shoot Blight (Formerly Known as *Diplodia* Tip Blight)

Pierluigi (Enrico) Bonello, James T. Blodgett, and Daniel A. Herms

Note: Pine shoot blight (pathogen: *Sphaeropsis sapinea)* is the new name for *Diplodia* tip blight (pathogen: *Diplodia pinea*).

Introduction

Pine trees and their diseases are much more important to the nursery industry than is often realized. The wholesale value of the nursery industry in the United States was $3,096,723,000 in 1998 (USDA 1998). Pines are the fourth largest selling species in nursery sales, with 30,068,000 plants produced annually for a total value of $108,840,000 (USDA 1998). Once pines are placed in the landscape and achieve ages of approximately 15 to 18 years, their values exceed $200 per tree, or a total estimated landscape value of approximately $6 billion.

In Ohio, the nursery / ornamental industry is estimated to have a value of $2.4 billion. Wholesale production of ornamental plants in Ohio exceeded $500 million in 1999, accounting for 12% of total agricultural production in the state, and making it Ohio's fourth leading agricultural commodity behind corn, soybeans, and milk (Randall *et al.*, 2000). Additionally, cash receipts for Ohio's landscape and garden center industries exceeded $1.5 billion dollars in 1996 (Rhodus, 1997).

Pines suffer major losses from plant diseases and insect pests. Historically, pesticides have been widely used to manage these problems of ornamental plants. For example, more than 27 million U.S. households used pesticides in 1989 to control pests of lawns, trees, and gardens (Raupp, Koehler, and Davidson, 1992). Because pesticide use can create risks to human health, the Food Quality Protection Act is restricting their use. This has increased the need for the development of alternative pest management strategies. In fact, the Ohio Nursery and Landscape Association (ONLA) rates the development of new and alternative IPM techniques and environmentally safe pesticides as the two top horticultural research needs.

Although plant disease resistance has been recognized as an ideal strategy for managing pests of ornamental plants and shade trees for many years, little progress has been made in the deployment of disease-resistant ornamental plants, or in understanding their resistance mechanisms

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(Herms, in press; Raupp, Koehler, and Davidson, 1992). If host-pest interactions were better understood in ornamental trees, it would be possible to manipulate them to minimize pest problems while reducing pesticidal inputs (Herms, Akers, and Nielsen, 1984). However, few studies have investigated these interactions in any detail.

Pines are affected by numerous diseases, particularly those caused by fungi, that often severely limit their ecological, environmental, and commercial value (Harrington and Wingfield, 1998). Some diseases also predispose trees to insect infestations. Thus, there is a clear incentive to minimize the negative impacts of fungal diseases on the health and productivity of pines in managed situations. A better understanding of the basic physiological and biochemical processes that influence the outcome of host parasite interactions in pines, and how these are affected / modulated by environmental variables, can contribute significantly to this objective. Systemic induced resistance can protect plants against both insects and pathogens. This is one reason why we are studying this approach to resistance in pines.

Systemic Induced Resistance

Systemic resistance can be induced in many plants by pathogens, chemicals, and by some beneficial microorganisms such as specific *Trichoderma* fungi and bacteria that colonize roots. This is how composts can induce resistance to foliar diseases in some plants. It is a subtle but important effect. This phenomenon is termed Systemic Induced Resistance (SIR).

Extensive research has been carried out in the last 20 years, and particularly in the last decade, to understand SIR. Most of the work has been conducted on herbaceous model plants, particularly tobacco and *Arabidopsis*, as these systems are quite responsive to genetic manipulation (Buell, 1999). This has resulted in the development of chemical inducers of resistance such as Actigard. SIR-type responses have been observed in pine also (Bonello, Gordon, and Storer, 2001).

In contrast to the rather extensive studies in herbaceous plants, there are, to our knowledge, no detailed data on these processes for conifers other than the studies described herein. Only one example of chemical induction of resistance in pines is known (Reglinski, Stavely, and Taylor, 1998).

Vigor and Disease Resistance

Little is known about how soil nutrients affect pine diseases. In a survey of red pine (*Pinus resinosa*) and jack pine (*P. banksiana*), tree mortality attributed to *Sphaeropsis sapinea* was as high as 30% for red pine and 51% for jack pine (Nicholls and Ostry, 1990). Such high mortality levels were attributed to, among other factors, poor site conditions.

However, in another field survey of red pines, mortality was correlated with paper-mill waste application and linked to higher foliar nitrogen in the treated stands (Stanosz and Trobaugh, 1996). Van Dijk *et al.* (1992) also correlated increased disease development by *S. sapinea* with high soil nutrient concentrations.

Although losses to *S. sapinea* have been associated with nutrient conditions, results are based on field observations and field surveys. These observations and surveys do not provide information on the quantitative effects of nutrition on disease development and cannot separate the effects of nutrients from many other possible environmental factors. Thus, basic studies must be performed. Preliminary data recently generated in our program have begun to answer some of these questions.

Sphaeropsis Shoot Blight of Austrian Pine

Austrian pine (*P. nigra*) is endemic to the Mediterranean basin (Barbero *et al.*, 1998), but it was one of the first tree introductions to the United States and was first reported in cultivation in 1759 (van Haverbeke, 1990). Today this species is commonly planted as an ornamental in the United States.

Sphaeropsis shoot blight and canker, caused by *Sphaeropsis sapinea* (formerly known as *Diplodia pinea*, the cause of Diplodia tip blight), has resulted in extensive damage to conifers throughout the world. Pines in Ohio and the rest of the Midwest are extensively affected by this disease. The pathogen also causes crown wilt, collar rot, and root disease. Pines are affected from seedling stage to mature size and damage occurs in natural stands, nurseries, Christmas tree and ornamental plantings, and in plantations (Chou, 1976; Gibson, 1979; Nicholls, Ostry, and Prey, 1977; Stanosz and Cummings Carlson, 1996).

Recent Progress in SIR Research in Pines

In recent experiments, trees were first inoculated in the lower stems. Later inoculation higher on the stem resulted in smaller lesions on trees that were inoculated at the base with *S. sapinea* compared with trees that were not inoculated at the base (i.e., the controls). This study confirmed that SIR occurs in this pine species as well as in Monterey pine (Bonello, Gordon, and Storer, 2001).

We also have preliminary data that show systemic accumulation in the induced trees, described previously, of chemicals active in resistance in pine trees, which further proves that we are measuring resistance and not some other unknown phenomenon (Blodgett and Bonello, 2001).

Lastly, we have recently found that fertilization of red pine trees with an N-P-K fertilizer in controlled field experiments significantly increased the severity of *Sphaeropsis* tip blight. Thus, higher host vigor (evident from superior growth rates of fertilized trees) appeared to increase disease susceptibility in this pine. These studies will be replicated with Austrian pine.

Conclusion

Our preliminary results, coupled with some of our previous research (Bonello, Gordon, and Storer, 2001), show that inducible defensive systems are not limited to herbaceous plants. Thus, systemic induced resistance, modulated by vigor, could potentially be developed into a viable pest management system for pines that is not solely reliant on fungicides. In the long run, a better understanding of these processes in our model system will allow for the development of integrated approaches to management of pests of other important woody ornamentals, in both the nursery and the landscape.

Acknowledgments

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Literature Cited

Barbero, M., R. Loisel, P. Quezel, D. M. Richardson, and C. P. Romaine. 1998. Pines of the Mediterranean basin. In: *Ecology and Biogeography of Pinus*, edited by D. M. Richardson. Cambridge: Cambridge University Press.

Blodgett, J. T., and P. Bonello. 2001. Systemic induction of ferulic acid and other phenolic compounds in *Pinus nigra* inoculated with *Sphaeropsis sapinea. Phytopathology* 91 (6 Supplement):S9.

Bonello, P., T. R. Gordon, and A. J. Storer. 2001. Systemic induced resistance in Monterey pine. *Forest Pathology* 31:99-106.

Buell, C. R. 1999. Genes Involved in Plant-Pathogen Interactions. In: *Induced Plant Defenses Against Pathogens and Herbivores*. Edited by A. A. Agrawal, S. Tuzun, and E. Bent. St. Paul, Minn.: APS Press.

Chou, C. K. S. 1976. A shoot dieback in *Pinus radiata* caused by *Diplodia pinea*. II. Inoculation studies. *New Zealand Journal of Forestry Science* 6:409-420.

Gibson, I. A. S. 1979. *Diseases of Forest Trees Widely Planted as Exotics in the Tropic and Southern Hemisphere. Part II. The Genus Pinus.* Kew, UK: Commonwealth Mycological Institute.

Harrington, T. C., and M. J. Wingfield. 1998. Diseases and ecology of indigenous and exotic pines. In: *Ecology and Biogeography of Pinus*. Edited by D. M. Richardson. Cambridge: Cambridge University Press.

Herms, D. A., in press. Strategies for deployment of insect resistant ornamental plants. In: *Mechanisms and Deployment of Resistance in Trees to Insects*. Edited by M. R. Wagner, C. Clancy, T. Paine, and F. Lieutier. Dordrecht, The Netherlands: Kluwer Academic Publishing.

Herms, D. A., R. C. Akers, and D. G. Nielsen. 1984. The ornamental landscape as an ecosystem: implications for pest management. *Journal of Arboriculture* 10 (11):303-307.

Nicholls, T. H., and M. E. Ostry. 1990. *Sphaeropsis sapinea* cankers on stressed red and jack pines in Minnesota and Wisconsin. *Plant Disease* 74:54-56.

Nicholls, T. H., M. E. Ostry, and A. J. Prey. 1977. *Diplodia pinea* pathogenic to *Pinus resinosa.*

Randall, A., A. E. Lines, E. Liu, J. Ramey, and W. F. Matthews. 2000. 1999 Ohio Farm Income. The Ohio State University. Ohio Agricultural Research and Development Center.

Raupp, M. J., C. S. Koehler, and J. A. Davidson. 1992. Advances in implementing integrated pest management for woody landscape plants. *Annual Review of Entomology* (37):561-585.

Reglinski, T., F. J. L. Stavely, and J. T. Taylor. 1998. Induction of phenylalanine ammonia lyase activity and control of *Sphaeropsis sapinea* infection in *Pinus radiata* by 5-chlorosalicylic acid. *European Journal of Forest Pathology* 28:153-158.

Rhodus, T. *Ohio Green Goods Industry Survey 1997.* Available from *http://www.hcs.ohio-state.edu/greengoods/greengoods.html.*

Stanosz, G. R., and J. Trobaugh. 1996. Can fertilization with paper mill waste sludge threaten forest health and productivity? Shoot blight and canker found in treated red pine stands. *Pulp & Paper Canada* 97:151-154.

Stanosz, G. R., and J. Cummings Carlson. 1996. Association of mortality of recently planted seedlings and established saplings in red pine plantations with Sphaeropsis collar rot. *Plant Disease* 80:750-753.

USDA. 1998. USDA Census of Agriculture: 1998. Census of Horticultural Specialties, Vol. 2.

van Dijk, H. F. G., M. van der Gaag, P. J. M. Perik, and J. G. M. Roelofs. 1992. Nutrient availability in Corsican pine stands in the Netherlands and the occurrence of *Sphaeropsis sapinea*: a field study. *Canadian Journal of Botany* 70:870-875.

van Haverbeke, D. F. 1990. *Pinus nigra* Arnold. European Black Pine. In: *Silvics of North America*. Washington, D.C.: USDA Forest Service.

Understanding Failures in Ornamental Weed Control: Forget the Excuses!

Hannah Mathers

Introduction

Rudyard Kipling wrote, "We have 40 million reasons for failure, but not a single excuse." In nursery weed control, there are countless reasons why the herbicides or other control practices we choose may not work in various situations; however, we can gain knowledge of what will work, and we can learn from our successes and failures. Oscar Wilde wrote, "Experience is the name everyone gives to their mistakes."

Weed control in ornamentals can take many forms. There are more options in field culture than in containers and container yards. In nursery fields, possible control methods include physical, biological, cultural, chemical, and combinations of these methods. Physical control failures may occur if cultivation is done during wet, cool, shady, low wind conditions allowing disturbed weeds to reestablish themselves; hand weeding is done after seed is produced; or the soil is dry and the reproductive plant parts are left behind. Cultivation and hand weeding can also fail if the piles of pulled or hoed weeds are not cleaned up and certain weeds continue to flower and ripen seeds after having been hoed or uprooted. Shifts of weed populations can occur when any type of control is used exclusively. Repeated mowing will result in a predominance of prostrate weeds.

Total reliance on cultivation will lead to a predominance of perennial weeds. Despite these examples of failure with physical control programs, failures in the chemical control program are probably the ones most managers often remember.

Herbicides are very effective tools for controlling weeds while reducing costs associated with physical weed removal. Herbicide selection depends on the weeds you are trying to control, the stage of the planting, the plant material in the planting and the stage of the weed growth. Other factors influencing herbicide selection include timing of the herbicide application; classification and persistence in the soil; the chemical mode-of-action; soil type; temperature; soil pH; organic matter content; available soil moisture; whether the weeds or crop plants are under stress; spray pattern; equipment calibration; chemical retention on leaf or soil surface; uptake in the weed; and spray water quality. Some of these factors will be discussed here.

Weed Identification

Identification of the weeds in your nursery is extremely important. Certain families of weeds respond to certain herbicides and not others. An example is the Mustard family (Brassicaceae). Treflan does not control Mustards. Failure to recognize

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shepherds purse as a member of the Mustard family and use of Treflan for control would be a waste of time, money, and chemical (Mathers and Leidenfrost, 1995). Another example is with the Pink family (Caryophyllaceae). Many Pink family members are resistant to Ronstar. Members of the Pink family include a number of annuals, biennials, or perennials, including corn spurry *(Spergula arvenis)*, chickweeds and stitchworts *(Stellaria* spp. and *Cerastium* spp.), bladder campion *(Silene vulgaris)*, pearlwort *(Sagina procumbens)*, and bouncingbet *(Saponaria officinalis)*.

Most preemergents work on members of the Pink family, including Simazine, Diuron, Casoron, Surflan, and Kerb; however, use of Ronstar would lead to a lack of control. An example of a weed that has become resistant to certain herbicides is common groundsel *(Senecio vulgaris)*, a prevalent weed and serious competitor in nurseries and landscapes. Strains of atrazine-resistant and glyphosate-resistant groundsel have emerged and are becoming an increasing concern. Other weeds with herbicide resistance are kochia, Russian thistle, prickly lettuce, wild oat, Italian ryegrass, Powell amaranth, and yellow starthistle.

Identification of weeds around the nursery is also very important. "Total farm weed control," including adjacent areas such as fence lines, roads, irrigation ditches, and around hoop-houses and other farm buildings, is essential. Most weeds invade the nursery from adjacent farm areas or field perimeters. Control of weeds from adjacent areas is a tough job for nursery managers. However, even if weed control in adjacent areas is unfeasible, identification of the potential weed species is still an option.

Identification to the family level often provides a large part of the information you need to identify the life cycle of the weed and which herbicide will be most effective. The first identification step at the family level is determining if your weeds are grasses, broadleaves, sedges, or rushes. There are several families of problematic broadleaf weeds that have species common in ornamental operations. In the Grass family (Poaceae), there are also numerous difficult ornamental weeds. The most common grassy weed is annual bluegrass. The Sedge family (Cyperaceae) and Rush family (Juncaceae) also have tough-to-control weeds but are not as common in ornamental culture within the western and Midwestern United States.

Herbicide Timing

Herbicides are applied either to the foliage of growing weeds (postemergence) or to the soil to prevent germination (preemergence). Postemergent foliar herbicides are either contact or systemic chemicals.

Contact herbicides weaken and disorganize the plant cell membranes causing leakage and eventual localized death. Contact herbicides are generally most effective against annuals. Complete coverage is essential in weed control with contact herbicides. An example of a contact herbicide is Gramoxone.

Systemic herbicides include the phenoxy herbicides (*e.g.*, 2,4-D) and dicamba, picloram, amitrole, and glyphosate. Systemic herbicides are translocated throughout the plant to their sites of physiological action. Translocated herbicides are effective against all types of weeds; however, they have their greatest advantage when used to control established perennials. Complete coverage is not required with translocated materials; however, uniform applications are critical.

Postemergents are generally best when applied to young plants and may take several days to work. The older formulations of Roundup, for example, would take 10 to 14 days to show activity. The newer Roundup Ultra formulation works much faster.

Postemergent contact with active growth of the ornamental plant, including green bark, will result in injury. So contact with the ornamental plant or conditions that could promote contact, such as high winds, should be avoided. Poor results can occur with postemergent applications if the weed is under stress at the time of application, if rainfall occurs within six hours, or if heavy rainfall occurs within two hours.

Preemergent herbicides (*e.g.,* Casoron, Surflan, Ronstar) are applied either to the soil or growing medium surface and are usually absorbed by root systems, or by emerging shoot tips as they make their way through the soil surface during seed germination. Most must be dissolved in the soil/medium to work. Generally, one-half inch of irrigation or rainfall after application of a preemergent is required to activate the herbicide. Soil type (sand, gravelly soils, clay), organic matter content, and temperature are all important in determining the effect and activity of a preemergent application. Because they are preemergents, they must be applied to weed-free surfaces. Generally, nurseries make two applications of preemergents per year, during the fall and spring.

There are also chemicals called soil fumigants. Soil fumigants are used to kill weeds and underground plant parts, but they are also used to control nematodes and disease-causing pathogens in the soil. Soil fumigants are used before planting high-value crops, for seedbed preparation, and sometimes before planting high-value landscapes or treating potting soil (Kuhns *et al.,* 1998).

Classification and Soil Persistence

Herbicides are classified as selective or nonselective. Selective herbicides control weeds without injury to the ornamental plants in the same application area. The tolerant ornamental plants will appear on the label. The nonselective herbicides will kill any plant or plant part they are applied to and are recommended for non-crop areas or as directed sprays only.

An example of a selective ornamental herbicide is Fusilade. It is a selective post-emergent and kills grasses but does not control broadleaf weeds. Fusilade can generally be applied over-the-top in non-grassy ornamental landscape beds and/or ground covers; however, the label does indicate certain ornamental plants, such as *Juniperus horizontalis,* that will be affected by over-the-top sprays. An examples of a nonselective herbicide is Roundup. Nonselective herbicides should never be applied over-the-top of ornamental plantings.

With increased use of herbicides, in some situations, nursery growers are concerned about herbicide persistence or residues affecting subsequent crops. Some pre-emergents persist in the soil, and some soil sterilants used along railroad embankments or under power lines are extremely persistent. Soils can be chemically analyzed for herbicide residues, but this is expensive, complicated, and can be done only in specialized laboratories. Moreover, the results of the analysis do not indicate the effects on the next crop.

An inexpensive and fairly reliable way to determine herbicide carryover is to do a crop biological assay, or a bioassay. A bioassay involves planting a sensitive indicator plant into soil collected from a site, then evaluating whether symptoms of herbicide injury develop. Bioassays should also be done if you are not certain of the previous cropping history of the field. Soil sampling for a crop bioassay is similar to sampling for fertilizer levels. Samples should be gathered from several areas of the field. Remember that the assay is only as reliable as the sample collected.

An example of a persistent preemergent is Casoron, which is tied up by organic matter and is slowly decomposed by soil microbes. Casoron residue damage generally shows up as one-directional rooting. Other injury symptoms of Casoron include leaf yellowing or veinal, interveinal, marginal, or overall chlorosis. At low concentrations, a halo effect, or marginal chlorosis, is evident. Injury appears on the new growth.

Simazine or Princep can build up in soils with repeated applications over several years. Simazine injury appears as yellowing or veinal, interveinal, marginal, or overall chlorosis. Injury appears first in the new growth, since the chemical is translocated to the growing point. Plants may outgrow injury, which is the result of low concentrations. The whole leaf may become chlorotic at high concentrations. Atrazine residues are more serious in northern climates as inactivation is very slow below 75ºF.

Mode-of-Action

Herbicides have a specific target site, a place in the plant that herbicides bind to and inhibit function (Hall *et al.*, 1999). Most target sites are enzymes; however, there are exceptions which interact with photosynthesis or are auxinic herbicides.

In North America, herbicides are divided into groups based on target site. Herbicides that affect the same target site frequently have the same symptoms, application method, constraints, and even toxicological profile (Hall *et al.*, 1999). The commonly used ornamental herbicides can be divided into 10 different groups as indicated in Table 1, with different sites of action:

- Group 1, ACCase inhibitors such as the Cyclohexanediones
- Group 2, ALS inhibitors such as the Imidazolines and Sulfonylureas
- Group 3, Microtubule assembly inhibitors such as the dinitroanalines
- Group 4, Synthetic auxins such as the phenoxy acetic acids
- Group 5, Photosystem II inhibitors such as the triazines
- Group 6, Photosystem II inhibitors with different binding behavior such as the benzothiadiazoles
- Group 7, Photosystem II inhibitors again with different binding behavior such as the ureas
- Group 9, EPSP synthase inhibitors such as glyphosate
- Group 22, Photosystem I electron diverters such as bipyridiliums
- Group 15, Unknown site of action herbicides such as the chloroacetamides.

Stage of Planting

A chemical weed control program for a commercial field stock nursery may include four parts (Mathers and Leidenfrost, 1995). The four parts may not be required in all situations or may not be advantageous in all types of ornamental operations.

The first component is a preplant application of a postemergent such as Glyphosate. Preplant, postemergents are applied to the top growth of weeds prior to working the soil and planting the nursery stock. Second is an application of preplant soil fumigant, and the third, a preplant application of a preemergent.

There are few preplant, preemergents registered for use in ornamental nurseries. One that is, however, is Treflan. Treflan applications can be made and incorporated from three weeks before planting to the time of planting. Treflan controls broadleaf and grass seedlings just after germination. Do not apply to wet soils or soils high in organic matter. The fourth part of the chemical control program will consist of postplant application(s) with selective

Table 1. Several Herbicides Registered for Outdoor Ornamental Production With Trade and Common Names and Chemical Group Indicated (Mathers and Mills, 2001).

Herbicides Class	Trade Name	Common Name
Amide	Gallery 75 DF	Isoxaben
	Snapshot 2.5 TG	Isoxaben + Trifluralin + Fertilizer
Benzamide	Kerb WSP	Pronamide
Benzonitrile	Casoron 4G	Dichlobenil
Benzothiadiazole	Basagran SG	Sodium bentazon
Chloroacetanilide	Pennant Liquid	Metolachlor
Cyclohexanediones	Vantage	Sethoxydim
Dinitroaniline	Barricade 65WG	Prodiamine
	Factor	Prodiamine
	Pendulum 2G, WDG	Pendimethalin
	Pendulum 3.3 EC	Pendimethalin
	Pre-M 60DG	Pendimethalin
	Pre-M 3.3 EC Turf	Pendimethalin
	Ornamental Weedgrass Control	Pendimethalin
	Rout	Oryzalin + Oxyfluororen
	Snapshot TG	Isoxaben + Trifluralin
	Surflan AS T/O	Oryzalin
	Treflan 5G	Trifluralin
	Trifluralin EC	Trifluralin
	OH II	Oxyfluorfen + Pendimethalin
Diphenylether	Goal 2XL	Oxyfluorfen
	OH II	Oxyfluorfen + Pendimethalin
	Rout	Oryzalin + Oxyfluororen
Dithiocarbamate	Nemasol 426	Metam Sodium

Table 1 (continued). Several Herbicides Registered for Outdoor Ornamental Production With Trade and Common Names and Chemical Group Indicated (Mathers and Mills, 2001).

Herbicides Class	Trade Name	Common Name
Imidazoline	Plateau	Ammonium salt
Oxadiazole	Ronstar 50 WSP, G	Oxadiazon
Oxime	Envoy	Clethodim
Phosphoric acid	Finale	Glufosinate ammonium
	Rattler	Glyphosate isopropylamine
	Roundup Pro	Glyphosate monoammonium salt
Phenoxy	Salvo	2,4-D Isoctyl [(2-ethylhexyl) ester]
Pyridine	Dimension	Dithiopyr
Aryloxyphenoxy propanoates	Fusilade II	Fluazifop-p-Butyl
Sulfonylurea	Manage	Halosulfuron-methyl
Thiadiazine	Basamid Granular	Dazomet
Triazine	Atrazine 4L	Atrazine
	Atrazine 90DF, 90WDG	Atrazine
	Princep Liquid	Simazine
	Simazine 4L, 90DF	Simazine
	Simazine 90WDG	Simazine
Urea	Diuron 4L	Diuron
	Diuron 80DF	Diuron
	Diuron 80WDG	Diuron

herbicides. Applications of selective herbicides used either for post or preemergence weed control can be applied over or between established ornamental crops, depending upon what the label reads (Mathers and Leidenfrost, 1995).

Temperature

Postemergent herbicides generally perform best at warmer air temperatures. The major effect of temperature is on rate of uptake of the herbicide. High temperatures favor rapid uptake, and generally favorable weed control can be obtained if the temperature is high at the time of application.

Not only does temperature affect herbicide uptake but temperature can also have a pronounced effect on dissipation or losses of herbicide from soils through volatilization and degradation (Fritz and Smith, 1975). Treflan for example, evaporates readily and vaporizes rapidly at high temperatures. The volatilization losses of Treflan can be reduced by cultural practices such as physical incorporation into the soil. Generally, the quicker a volatile herbicide is incorporated into the soil after application the better.

The volatility of herbicides also influences their extent of application in established nursery stock. Casoron, as an example, is so volatile at soil temperatures above 50ºF, that its use is limited to late fall, winter, and early spring applications.

Final Points

Once you have selected the herbicide that will work best for you, be sure your spray equipment is properly calibrated to deliver the right amount of herbicide. Recent surveys have indicated that 63% of growers erred in 10% or more of herbicide applications (Cranston, 1995). Over-application can result in crop damage and waste of money. Under applying can cause poor weed control and again waste money. The majority of herbicide problems are a result of inaccurate application. Equipment calibration is essential to implementing your weed control program properly.

Soil preparation is also very important. Most preemergents require well-worked soil, moist and smooth, free of clods and trash, to obtain uniform chemical distribution.

Lastly, timing is key. Early diagnosis of your weed problems and early treatment cannot be overemphasized. You don't want to get behind in weed management (Neal, 1999). Remember Oscar Wilde's instruction that experience is the greatest teacher. If our experiences have taught us nothing else, in ornamental weed control, it is to avoid the problems of dealing with weeds that are beyond the point of successful control.

References

Akers, M. S., Carpenter, P. L. and Weller, S. C. 1984. Herbicide Systems for Nursery Plantings. *Hortscience* 19(4): 502-504.

Cranston, R. 1995. *Weed Control: An Introductory Manual.* BC Ministry of Agriculture, Fisheries and Food.

Fretz, T. A. and E. M. Smith. 1975. Why Herbicides Fail. *American Nurserymen.* Jan. 1, 1975.

Hall, L., Beckie, H., and Wolf, T. M. 1999. *How Herbicides Work.* Alberta Agriculture, Food and Rural Development. pp. 134.

Kuhns, L. J., Harpster, T., Guiser, S., and Rose, M. A. 1998. *Controlling Weeds in Nursery and Landscape Plantings.* Ohio State University Extension. pp. 48.

Mathers, H. and Leidenfrost, P. 1995. *Nursery Crop Production Guide for Commercial Growers.* BC Ministry of Agriculture, Fisheries and Food.

Neal, J. 1999. Weeds and You. *Nursery Management & Production.* Vol. 15(1).

Preventing Problems While Capitalizing on Beneficial Impacts of Mulching

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Summary

Composts and mulches can be used successfully to enhance tree health. Unfortunately, application of these organic amendments can also have negative effects. The most critical factors that contribute to success or failure associated with utilization of organic mulches and composts are reviewed here.

Discussion

Fresh vs. Composted Organic Matter

Fresh plant materials often have negative effects on plant growth and/or health for some time after application. For example, fresh straw mulch increases water retention in heavy soils, immobilizes nitrogen, and results in poor growth. It may also increase *Phytophthora* root rot. Fresh ground wood has similar negative effects. Another problem with fresh materials is that beneficial microorganisms which suppress plant diseases do not express their beneficial effects because of the excess of free nutrients. Therefore, pathogens grow and diseases develop.

In contrast, ground wood that has been stabilized by composting has beneficial effects. It improves plant growth and can also provide biological control of root rots. The same results have been obtained with composted tree barks and several other types of composts, but many factors must be considered to provide consistent effects. When composts are to be incorporated into soil, the stability of the organic matter must also be considered.

Why do fresh woody mulches have these negative effects on plant health? Fresh materials incorporated into soil release sugars and other readily available nutrients as they first begin to decay. This stimulates plant pathogens such as *Rhizoctonia* and *Pythium* spp. that cause damping-off of seedlings. The *Armillaria* fungus, which can kill mature trees, and nuisance fungi also are stimulated directly by application of fresh wood.

Fresh organic matter that is decomposing rapidly binds water, making it "slippery" when wet. Heavy soils that are low in organic matter, when mulched with these fresh materials, can remain too wet in the spring. This aggravates root rots caused by *Pythium* and *Phytophthora* spp. In dry climates and on soils covered with a layer of duff, as in forest litter, this does not occur.

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Organic matter acquires beneficial characteristics as soon as it becomes partially decomposed and soil microorganisms begin competing for nutrients. Pathogens now are suppressed or killed and beneficial microorganisms thrive, including mycorrhizal fungi. The structure of the soil is also improved by partially decomposed organic matter. This results in better water retention under dry weather conditions and better drainage during periods of high precipitation, which in turn leads to root rot suppression.

Soil fertility is also improved by partially decomposed mulches or composts. As organic matter decomposes in or on the soil surface, nutrients are released and fulvic and humic acids are formed. Fulvic and some humic acids remain dissolved in soil water early in the decomposition process. These acids chelate trace elements such as iron, zinc, manganese, and copper, and improve their availability even at high soil pH. This is one reason why composted manures and sludges "green up" plants on some alkaline soils. These beneficial effects usually do not last more than one or two years.

After the organic matter in soil has fully decomposed, fulvic acids are no longer produced and iron deficiency due to high pH occurs again. Highly stabilized sources of organic matter, such as peat or organic matter in muck soils, or in soils low in organic matter, do not provide these same beneficial effects. Root rot pathogens typically cause losses in such soils and peat mixes unless pesticides are used.

Nuisance Fungi in Mulches

Several factors contribute to growth of nuisance fungi on mulches. The four most important factors are:

- The extent to which the organic fraction in the mulch or compost has been decomposed.
- The moisture content
- The temperature
- The pH of the materials when the mulch is applied.

Most nuisance fungi grow naturally on the cellulose or the lignin in the mulch while it decays. Others such as slime molds (dog vomit fungus) grow on microorganisms that decay the mulch.

Landscapers often apply mulch from high temperature (120 to 160ºF) piles directly into the landscape. The beneficial microorganisms in these hot composts cannot grow after the mulch cools (60 to 80ºF) in the landscape. They cannot compete with dominant soil microorganisms; thus, they die and this leaves a "biological vacuum." The microorganisms that fill this vacuum become the predominant initial colonizers.

If the hot mulch is wet (45 to 60% moisture content), then bacteria as well as fungi colonize the food base. If it is fresh bark or woody mulch, then a lot of food is available for organisms to consume as opposed to a stabilized compost that resists colonization by microorganisms. Certain bacteria produce antibiotics, and this suppresses colonization by fungi. However, if the moisture content of the hot mulch is low (less than 34%, *i.e.*, dusty), then fungi become the predominant colonizers.

This produces a moldy product over a two-week period. After heavy rains when this material becomes wet, bacteria and other microorganisms colonize the fungi on the mulch. The fungi produce fruiting structures thereafter which we see as toadstools, spore masses from the shotgun fungus, the beautiful birds nest fungi, and more. Thus, high temperature, dry, relatively fresh, woody mulch applied to the landscape produces fungal problems. As decomposition progresses, mulches have a higher nitrogen content, and this also favors bacteria over fungi. Therefore, problems are less severe on partially composted mulches.

The pH of mulch plays a role as follows: Bacteria in general do not colonize mulches if the pH is below 5.0. Fungi predominate on low pH mulches. Thus, sour mulch, which has fermented to produce vinegar and other organic acids in anaerobic (no oxygen), large, compacted storage piles, inhibits bacteria even when its moisture content is high. Dry, sour mulches seem to cause the worst problems. In bagged products, the same problems develop when the moisture content and pH are low. Water from biological activity condenses along the edge of bags. After some time, enough water is present there to stimulate fruiting of fungi induced by bacterial growth.

How does one avoid these problems? Maintain a moisture content greater than 45% on a weight basis in the mulch. Soak it with water during mulching to set up competition for fungi. Avoid using sour mulches. Finally, use mulches that have been partially decomposed and avoid high wood fiber content materials.

Timing of Application

In Ohio's climate, composts that are high in salinity (composted manures, sludges) and fresh materials that have not been composted should be applied in the fall or winter when pathogens and the crop are least active. This allows time for leaching of salts and for decomposition and establishment of beneficial effects. Composted sewage sludges and manures that are high in salinity often increase disease pressures rather than provide control, if applied in the spring or summer when *Phytophthora* and *Pythium* are most active.

The best approach is to blend materials high in nitrogen content and salinity with woody mulches to provide long-lasting beneficial effects. After two to four months of composting, these blends can be applied as mulches at any time of the year and provide beneficial effects consistently.

Optimum Depth of Mulch Layer

Most mulches need to be applied to a depth of two to three inches to provide weed control. Some landscapers apply mulches to a depth of four to six inches, or even deeper. This can decrease colonization of trees by mycorrhizal fungi and increase root diseases such as *Armillaria* trunk decay and root rot. In contrast, mycorrhizal fungi are stimulated by organic amendments if the correct amount and type of material is applied, thus promoting plant health and vigor.

How Long Do Effects Last?

The effects of a two- to three-inch layer of hardwood bark lasts well into the third year. The lignin (dark material) and waxes in bark resist decomposition, which is the reason for the long-term effect. Pine bark harvested from 20-year-old trees typically is at least an inch thick and consists almost entirely of lignin and waxes. When used as mulch, this type of bark lasts for several years. Bark from Western Ponderosa pines (decorative bark) lasts even longer. However, much of the pine bark sold as mulch today is harvested from 10- to 12-year-old trees. This thinner and younger bark breaks down more readily but still forms a good mulch that typically does not immobilize nitrogen as long as its wood content is low.

Composted manures, biosolids, and leaves decompose rapidly and should be incorporated into the soil based on fertility needs. These amended soils then should be mulched thereafter for optimum effects. The length of time that each product lasts depends on the resistance of the material to decay and how it was treated during storage. The best time for soil incorporation is in the fall.

Fertility Values of Composts

Fertility affects disease severity. The emphasis here is on nitrogen availability because it varies most severely among nutrients released from composts and mulches and has the greatest impact on plant disease severity. Composted biosolids, cow and swine manures, typically contain 1.7 to 2.5% total nitrogen (dry wt.), or even more. Typically, 20 to 25% of the total nitrogen in these materials is released within the first three months after utilization. The remainder is released over a long period of time. The fertility values of these products obviously must be considered.

Composted biosolids or manures should be incorporated into container media at not more than 8 to 12% by volume. At higher levels, they can have toxic effects. Composted poultry manure should be applied as a top dressing. It may contain 3 to 5% nitrogen. An inch of composted biosolids tilled into the top four inches of soil prepares an ideal seed bed for turf grasses. Low fertility crops such as rhododendrons should be treated with very low quantities of this type of compost. If excessive quantities are applied, then the plant becomes too succulent and this aggravates foliar and dieback diseases.

Leaves composted passively in piles for two years with infrequent turning tend to yield a product similar to that composted in windrows for one year with frequent turning. Passively composted leaves applied three inches deep on a sandy soil, followed by reapplications of one inch per year, provide many nutrients required for most crops. The concentration of nitrate in ground water under these plots remains below 10 ppm. It is clear, however, that compost loading rates need to be reduced after several years of applications due to release of nitrate and other nutrients from the more resistant to decomposition organic matter which accumulates in treated soils over time.

The concentration of total nitrogen in composted yard wastes may range from 0.7% to 2.0%. Fresh wood and bark contain only 0.1 to 0.3% N. Composted yard waste with a nitrogen concentration lower than 1.4% does not release significant quantities of nitrogen immediately after its incorporation. Batches of composts even lower in N should only be used as mulches or composted further to reduce the carbon content and thus the C:N ratio. Composted yard wastes with a total N concentration of 1.9% have provided excellent growth and suppress root diseases and in some instances also foliar diseases, whether incorporated into soil or used as mulches.

Summary

When used properly, composted organic matter applied as mulches or incorporated into the soil benefits plant health through several mechanisms. It is best to apply composted products, but if fresh organic matter must be used, it should be applied in the late fall or winter. Compost analysis, soil test results, and crop need should together form the basis for determining application rates. Do not apply more available mineral nutrients than is required by the crop. The frequency of application varies from crop to crop and product to product. It is most important to use these products when trees are first planted or when lawns are first established.

Mulch Effects on Soil Microbial Activity, Nutrient Cycling, and Plant Growth in Ornamental Landscapes

John E. Lloyd, Daniel A. Herms, Benjamin R. Stinner, and Harry A. J. Hoitink

Summary

Mulches with high carbon-to-nitrogen (C:N) ratios are thought by some to induce nitrogen deficiencies in plants by stimulating microbial growth, which depletes underlying soils of available nitrogen. On the other hand, mulches with low C:N ratios may increase soil fertility and plant growth as nutrients are released from mulch as it decomposes. We quantified the effects of mulching with composted yard waste (C:N ratio less than 20:1) and recycled wood pallets (C:N ratio greater than 100:1), as well as fertilization, on soil organic matter, microbial activity, nutrient availability, and the growth of river birch and rhododendron.

Both mulches increased soil organic matter and microbial biomass, which is consistent with the hypothesis that growth of soil microbes is limited by available soil carbon. Effects on nitrogen availability and plant growth, however, were highly dependent on the C:N ratio of the mulch. Mulching with low C:N composted yard waste dramatically increased total soil nitrogen, while mulching with ground wood had little effect. The rate at which nitrogen was released from decomposing mulch was much greater in plots mulched with composted yard waste, which substantially increased nitrogen availability and plant growth, as well as flower production of rhododendron.

Fertilization increased the growth of plants in the bare soil and wood pallet treatments, but had no effect on the growth of plants mulched with composted yard waste, which demonstrates that composted yard waste serves as high-quality organic fertilizer as it decomposes. On the other hand, the high degree of microbial immobilization of nitrogen in plots mulched with wood pallets induced nutrient deficiencies and greatly decreased plant growth. The high carbon content of the ground wood stimulated the growth of soil microbes, which out-competed plants for the limited nutrient supply. Fertilization relaxed competition between plants and microbes, but only to a degree.

This study demonstrates conclusively that organic mulches can have major effects on soil fertility and plant growth that are

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dependent on their C:N ratio. Understanding the dominant influence of soil microbes on nitrogen availability is key to understanding dynamics of soil fertility.

Introduction

Nutrient cycles have been studied thoroughly in forested and agricultural ecosystems (Facelli and Pickett, 1991; Wardle, 1992; Attiwell and Adams, 1993; Mary *et al.*, 1996). In contrast, nutrient cycling has received little attention in ornamental landscapes, and effects of mulch on soil fertility have been largely ignored.

Organic matter, such as leaves and grass clippings, is often collected and removed from ornamental landscapes, which disrupts nutrient cycles, and can increase reliance on inorganic fertilizers. Mulches are used widely to suppress weeds, conserve soil moisture, direct traffic flow, and enhance the beauty of landscapes (Robinson, 1988). Depending on their composition, some mulches may also have substantial effects on soil fertility and plant growth.

Mulches with a high carbon-to-nitrogen (C:N) ratio, such as recycled wood pallets, hardwood bark, straw, and sawdust are thought by some to induce nutrient deficiencies in plants by stimulating microbial growth, which depletes underlying soils of available nutrients. On the other hand, mulches such as composted yard waste and wood or bark blended with composted manure or sewage sludge may increase soil fertility and plant growth because their low C:N ratio resembles high-quality forest litter.

Mulches derived from the bark of mature softwood trees, such as cypress and pine, are quite resistant to decomposition by microbes and thus have little effect on nutrient availability. The key to understanding how different mulches affect soil nutrient availability lies in understanding the role of soil microbes in nutrient cycling, and how they respond to addition of organic matter.

Organic Matter, Soil Microbes, and the Cycling of Nutrients

As with plants, soil microorganisms (fungi, bacteria) require energy and essential nutrients to grow and reproduce. While plants derive their energy from carbon acquired from the atmosphere by means of photosynthesis, the carbon in decomposing organic matter provides soil microbes with their energy supply.

However, both plants and soil microbes utilize the same pool of essential soil nutrients. Since nitrogen is the nutrient that most often limits plant growth, the effects of mulch on soil fertility generally will be determined by how mulch impacts the outcome of competition between plants and microbes for this key nutrient.

Nitrogen and other nutrients are cycled as organic matter is decomposed by soil microbes (Figure 1). Rate of decomposition of organic matter is affected by many factors including soil moisture, temperature, and oxygen levels but is highly dependent on the total biomass of microbes in the soil (Wardle, 1992). Since microbes are generally limited by the supply of available carbon, microbial biomass can increase quickly when a biodegradable source of organic matter is applied to the soil surface.

As microbes decompose mulch on the soil surface, they acquire nutrients from the soil below in several ways. Fungal hyphae forage for nutrients in the soil much like plant roots (Frey *et al.*, 2000). Nutrients can also be carried toward the surface in soil water by diffusion as well as mass flow driven by evapotranspiration. Furthermore, the soil is worked continuously by earthworms, insects, and natural weathering

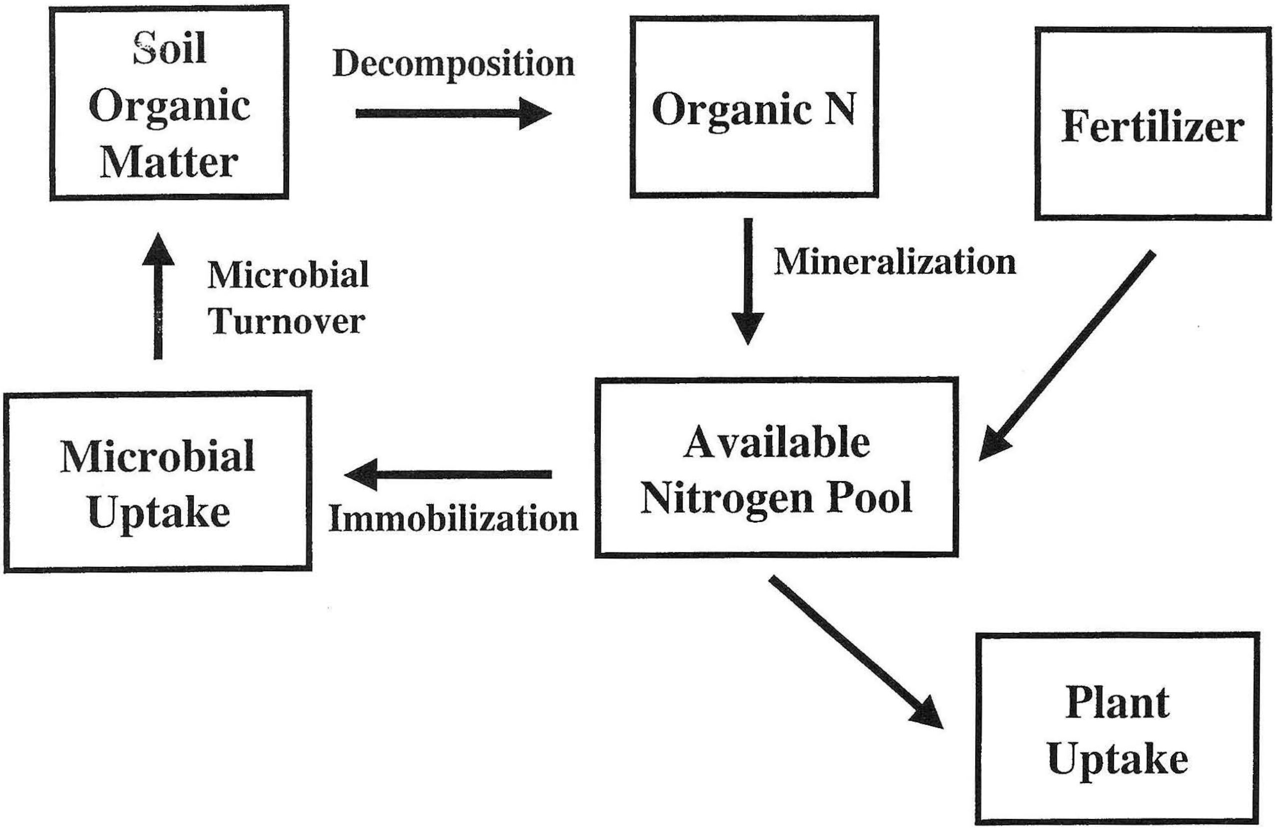

Figure 1. A conceptual model of nitrogen cycling in ornamental landscapes. Decomposing organic matter releases organic nitrogen that is mineralized into forms available for plant and microbial uptake. Fertilization supplements the available nitrogen pool. Nitrogen acquired by microbial biomass is immobilized and thus is unavailable for plant uptake. As microbes die and are themselves decomposed, nitrogen is returned to the available pool.

processes, which act to stir the nutrient pool and incorporate decomposing organic matter.

In a process known as nitrogen mineralization, inorganic forms of nitrogen (ammonium, nitrite, and nitrate) are released from organic matter as it is decomposed. Once in mineral form, nitrogen can be taken up and used by plants. Recent studies indicate that plants can also utilize dissolved organic nitrogen released from decaying organic matter (Nasholm *et al.*, 1998, 2000).

Plants and microbes compete for available nitrogen, and the process of nitrogen uptake by microbes is referred to as nitrogen immobilization, since any nitrogen acquired by microbes is not available to plants. Microbial turnover occurs as microbes die and are themselves decomposed, which releases nutrients that can then be acquired by living microbes or by plants.

C:N Ratio of Mulch as a Key Determinant of Nitrogen Availability

The amount of nitrogen available for plants is determined by the net balance between the rate of nitrogen mineralized from decomposing organic matter and the rate that nitrogen is immobilized by growth of soil microbes. Microbes are considered to be stronger competitors than plants for nitrogen (Kaye and Hart, 1997). In soils where nitrogen is limiting, microbes generally out-compete plants for nitrogen, resulting in plant nutrient deficiencies and decreased plant growth. In fertile soils, there may be enough nitrogen to adequately support both microbial and plant growth.

The balance between nitrogen mineralization and immobilization is strongly influenced by the C:N ratio of the decaying organic matter (Facelli and Pickett, 1991; Kaye and Hart, 1997; Mary *et al.*, 1996). Since soil microbes are generally carbon-limited, the addition of organic matter to the soil stimulates microbial growth. Organic matter with a high C:N ratio (greater than 30:1) does not contain enough nitrogen to fully support microbial growth. Therefore, microbes must scavenge additional nitrogen from the soil as they decompose high C:N organic matter, which decreases the amount of nitrogen available to plants.

Addition of nitrogen fertilizer to high C:N mulch (1 to 2 lbs N / 1,000 ft^2 is often recommended) can relax nitrogen competition between plants and microbes and stimulate plant growth. Conversely, decomposition of organic matter with a C:N ratio less than 30:1, which contains more nitrogen than required to support microbial growth, increases the availability of nitrogen for plants.

Mulch and Nutrient Cycling: An Experimental Test

Our research has focused on whether this model of nutrient cycling, developed primarily through studies of forested and agricultural ecosystems, can explain effects of organic mulch on soil fertility and plant growth in ornamental landscapes. We compared two organic mulches that differ dramatically in their C:N ratios — recycled ground wood pallets with a C:N ratio greater than 100:1, and composted yard waste (a blend of wood chips, leaves, and grass clippings) with a C:N ratio less than 20:1. The availability and use of both products as mulch is increasing dramatically because of increased recycling in an effort to divert organic wastes from landfills (Glenn, 1999; McKeever, 1999).

Because these products vary widely in their C:N ratios, we predicted that they would have dramatically different effects on nitrogen availability and plant growth. Composted yard waste, with its low C:N ratio, should release nutrients at optimal rates in slow release form, thereby increasing soil fertility and plant growth. Conversely, we predicted that the high C:N ratio of ground pallets would induce nutrient deficiencies and decrease plant growth by stimulating the growth of carbon-limited microbes, resulting in high rates of nutrient immobilization.

A field study was conducted in replicated plots at The Ohio State University's Ohio Agricultural Research and Development Center in Wooster from 1998 - 2000. Plots were mulched with composted yard waste, ground wood pallets, or were left untreated as bare soil controls. Mulch was applied to the soil surface in a layer two inches thick. Each spring, any residual mulch still remaining was removed and replaced with fresh mulch.

To determine how fertilization might interact with mulch to affect nutrient availability, half of the replicate plots from each of the three treatments were fertilized, and the other half were left unfertilized as controls. The fertilizer used was 18:5:4 NPK, with 56% of the nitrogen in slow release form (methylene urea), and 44% of the nitrogen in fast release form (17% ammonium nitrate and 27% water soluble urea). Fertilizer was applied at a moderate rate of 3 lbs N / 1,000 ft^2 / yr (2 to 6 lbs N / 1,000 ft^2 / yr is the recommended rate for trees and shrubs), with half of the annual amount applied at budbreak in spring and half in early October.

To determine how the experimental treatments affected soil parameters, soil was periodically sampled through the growing season to a depth of 6 inches (the zone in which most fine root activity and nutrient uptake by woody plants occurs). Soil samples were then analyzed for organic matter content, microbial biomass, total extractable nitrogen, immobilized nitrogen, nitrogen mineralization rate (the rate at which inorganic nitrogen is released from decomposing organic matter), and nitrogen in forms available for plant uptake (dissolved organic nitrogen and mineral nitrogen, including ammonium, nitrate, and nitrite).

The data reported represent the average of five sampling dates over the course of the 1999 growing season. A river birch (*Betula nigra* 'Cully Heritage') and rhododendron (*Rhododendron* 'Pioneer Silvery Pink') were planted in each plot to determine how these soil treatments impacted the growth of ornamental trees and shrubs. We also quantified flower production of rhododendron.

Mulch and Nutrient Cycling: Research Results

Mulching with composted yard waste and ground wood pallets had dramatic effects on soil organic matter, microbial activity, and nitrogen cycling that were apparent after only one season. Both mulches increased organic matter content of the soil relative to the bare soil control, with the yard waste mulch having the most substantial effect (Figure 2). Both mulches also increased microbial biomass as indicated by increased microbial nitrogen and a doubling of soil respiration (Figure 3). These results are consistent with the hypothesis that soil microbes are carbon limited, and that the addition of organic carbon can increase microbial biomass in the soil.

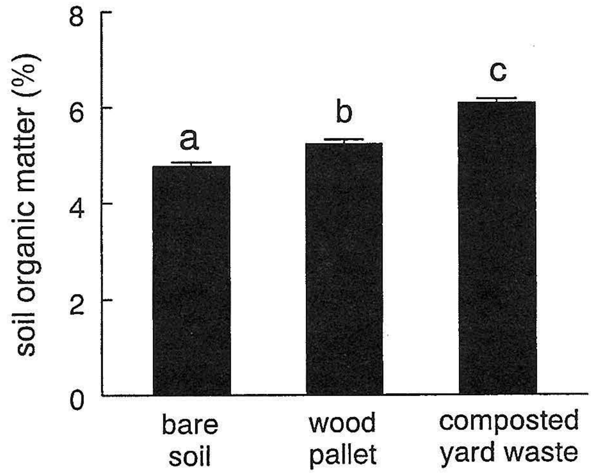

Figure 2. Effect of mulching with composted yard waste and recycled wood pallets on soil organic matter. Means (one standard error) with different letters are significantly different (LSD test, $p < 0.05$).

The effects that the increased organic matter and microbial activity had on nitrogen availability and plant growth, however, were highly dependent on the C:N ratio of the mulch. The low C:N composted yard waste mulch dramatically increased total extractable soil nitrogen, while mulching with ground wood had little effect (Figure 4a). This is not surprising given the high concentration of nitrogen in the yard waste mulch (about 2%) relative to that of the wood pallet mulch (less than 0.5%).

Most of the total soil nitrogen pool was tied up by soil microbes in all treatments, but the proportion immobilized by microbes was higher in plots mulched with wood pallets (83%) than in the bare soil (76%) or composted yard waste (72%) treatments (Figure 4b). Microbial immobilization of such a high proportion of the already small pool of total nitrogen in the wood pallet plots would leave little left for plants. In the yard waste treatment, on the other hand, immobilization of a smaller proportion of a

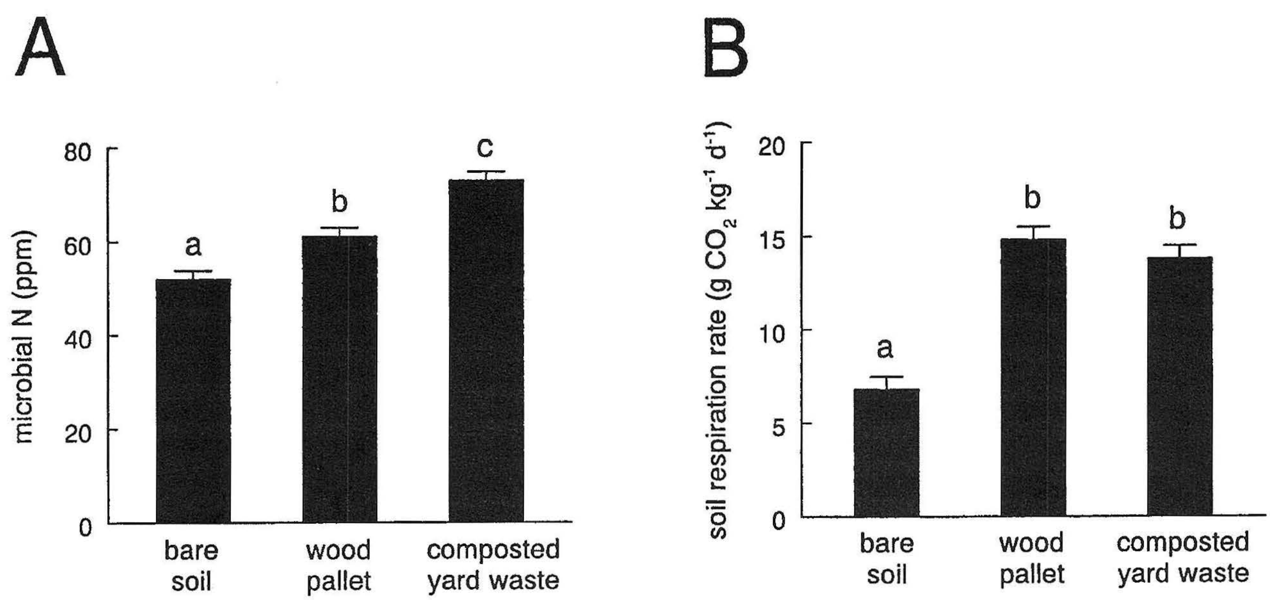

Figure 3. Effect of mulching with composted yard waste and recycled wood pallets on microbial biomass as indicated by the amount of nitrogen contained in soil microbes **(A)** and rate of microbial respiration **(B)**. Means (one standard error) with different letters are significantly different (LSD test, $p < 0.05$).

much larger nitrogen pool should result in much higher levels of nitrogen available for plants.

Indeed, the rate at which nitrogen was released from decomposing organic matter (nitrogen mineralization rate) was much higher in plots mulched with composted yard waste than in the wood pallet treatment (Figure 4c). This greatly increased nitrogen in forms available to plants (dissolved organic N, ammonium, and nitrate) (Figure 4d), and ultimately nutrient uptake (foliar nitrogen concentrations were 20 to 25% higher in the composted yard waste than in the bare soil or wood pallet treatments), as well as growth of river birch and rhododendron (Figure 5). Furthermore, mulching with composted yard waste increased flower production of rhododendron by more than 300% relative to the wood pallet and bare soil treatments (Figure 6).

Mulching with yard waste also had other substantial beneficial effects. Available phosphorus and potassium were increased, as was soil cation exchange capacity. Furthermore, bulk density was decreased by 10%, which improves soil tilth and reduces compaction. Fertilization had no additional effect on the growth of plants mulched with composted yard waste (Figure 5), indicating that nutrients released by decomposition of the compost were able to meet fully the requirements of both microbes and plants, making additional fertilization unnecessary.

Fertilization of plants growing in bare soil increased their growth to the same level as those mulched with composted yard waste, further indicating that mulching with this compost can serve as high-quality organic fertilizer.

On the other hand, the very high degree of microbial immobilization of nitrogen in the wood pallet treatment greatly reduced the rate of nitrogen mineralization (Figure 4c), which resulted in a much smaller pool of nitrogen in forms available for plant uptake (Figure 4d). A similar pattern was observed for soil phosphorus levels. Not surpris-

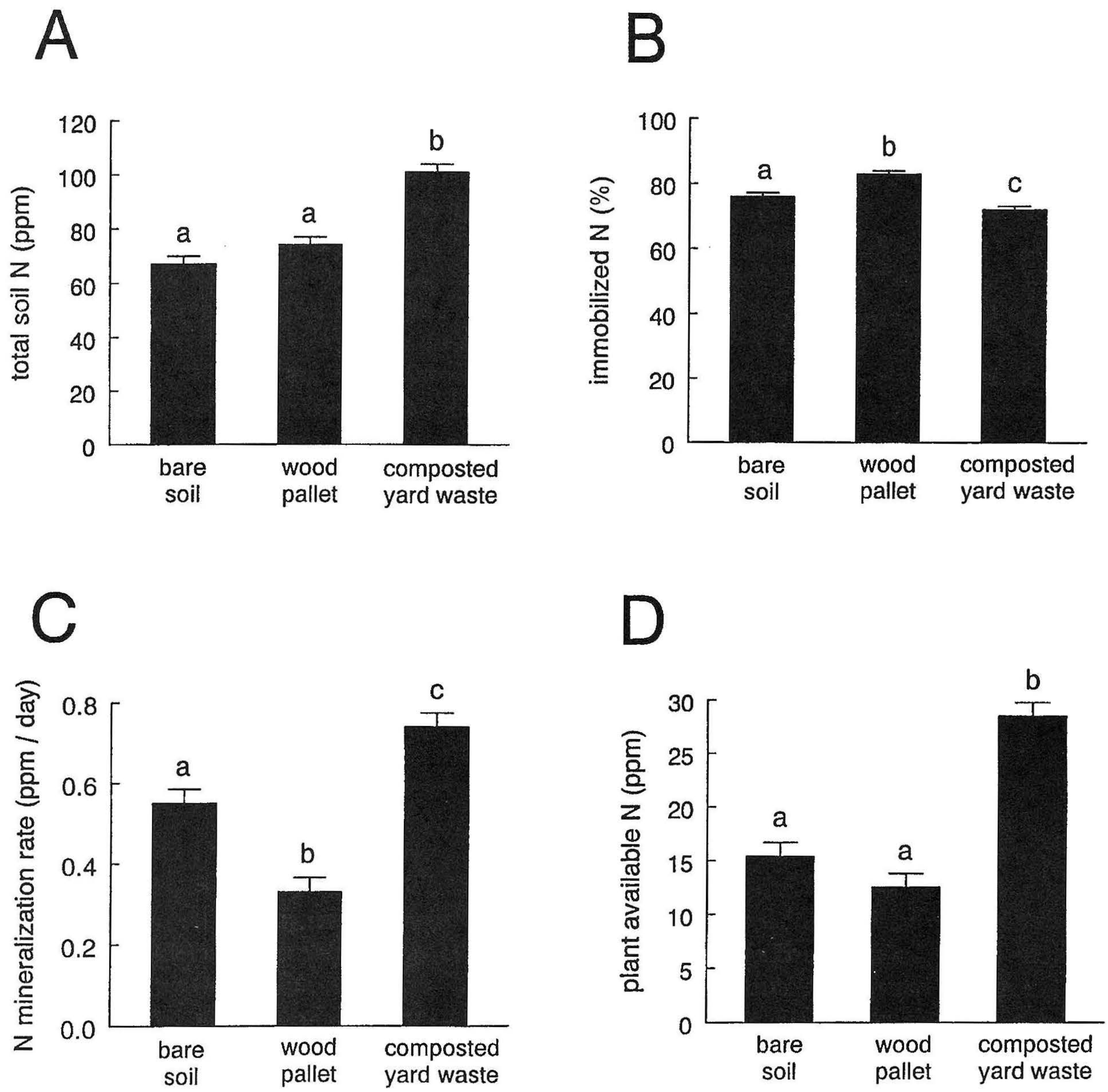

Figure 4. Effect of mulching with composted yard waste and recycled wood pallets on total extractable soil nitrogen **(A)**, percent of total soil nitrogen immobilized by soil microbes **(B)**, rate of nitrogen mineralization **(C)**, and amount of nitrogen in forms available to plants (NH_4, NO_3, NO_2, and dissolved organic nitrogen) **(D)**. Means (one standard error) with different letters are significantly different (LSD test, $p < 0.05$).

ingly, nutrient uptake was reduced and plants grew much slower when mulched with recycled wood pallets (Figure 5). These results are consistent with the hypothesis that soil microbes are better competitors for nutrients than are plants, and that addition of organic matter with high C:N ratios can induce nutrient deficiencies in plants by stimulating microbial growth. Fertilization relaxed the competition between plants and microbes for nitrogen and phosphorus in the ground wood treatment, thereby increasing plant growth. However, fertilization increased growth of rhododendron only to the level of plants growing in the untreated bare soil (Figure 5a), indicating that fertilization was able to compensate only partially for the nitrogen

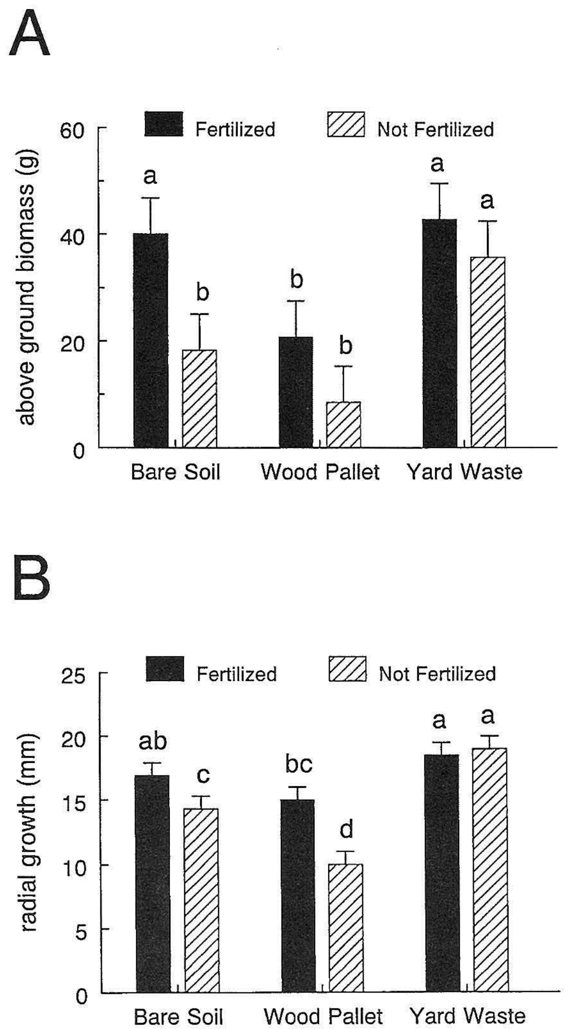

Figure 5. Effect of fertilization and mulching with composted yard waste and recycled wood pallets on total above-ground biomass of Pioneer Silvery Pink rhododendron **(A)**, and radial trunk growth of Heritage river birch **(B)**. Means (one standard error) with different letters are significantly different (LSD test, p <0.05).

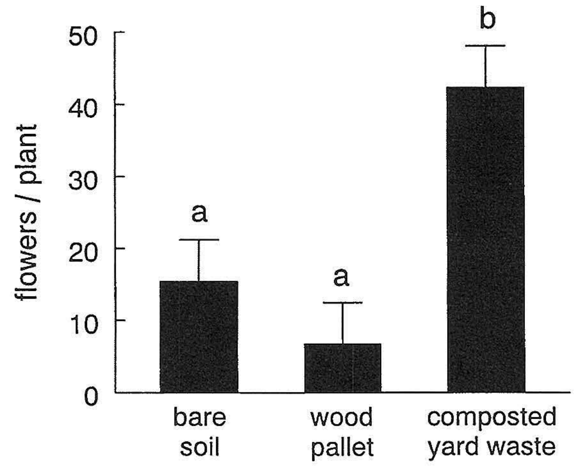

Figure 6. Effect of mulching with composted yard waste and recycled wood pallets on flower production of Pioneer Silvery Pink rhododendron. Means (one standard error) with different letters are significantly different (LSD test, p <0.05).

immobilizing effects of the wood pallet mulch. Fertilization of rhododendrons in the bare soil treatment resulted in plants that were 100% larger than fertilized plants that were mulched with ground wood pallets. However, fertilization increased the growth of river birch mulched with wood pallets to levels nearly equal to that of fertilized plants in the bare soil treatment (Figure 5b). This indicates that river birch was better able to compete with microbes for nitrogen than was Pioneer Silvery Pink rhododendron. Surprisingly, fertilization had little effect on soil organic matter, microbial biomass, or total extractable nitrogen. Fertilization did increase soil nitrate levels, but the effect was small and short-lived relative to the dramatic effects of mulching with composted yard waste.

Increased plant growth in response to mulching has been attributed primarily to conservation of soil moisture and weed suppression. In our study, neither of the mulches had any effect on soil moisture or average soil temperature, and plots were fastidiously weeded, so these variables were not a factor. Rather, the primary effects of mulches were conclusively linked to the impacts of their C:N ratio on microbial biomass and nutrient cycling as they decomposed. Clearly, understanding the dominating influence of soil microbes on nitrogen availability is key to understanding the dynamics of soil fertility.

Horticultural Implications

Mulching is one of the most widely used cultural practices in ornamental landscapes. Our research has shown that organic mulches can have major effects on soil fertility and plant growth. Mulching with low C:N composted yard waste increased plant growth by increasing soil organic matter, microbial biomass, and nutrient availability, which demonstrates that composted yard waste serves as high quality organic fertilizer as it decomposes.

On the other hand, high C:N mulch derived from recycled wood pallets induced nutrient deficiencies and decreased plant growth. The high carbon content of the ground wood stimulated the growth of soil microbes, which competed more successfully than plants for the limited supply of nutrients.

The nitrogen-depleting effect of mulch diminishes over time as it decomposes. As microbes die and decompose, the nitrogen they contain is released for use by plants unless the carbon source is replenished by adding fresh mulch. Nitrogen immobilization by microbes will probably have a greater impact on herbaceous plants and newly transplanted woody plants than on well-established trees and shrubs with extensive root systems.

Nevertheless, it may be best to reserve mulches with a high C:N ratio for use away from plants, such as on paths. Alternatively, these products can be blended with composted materials with a low C:N ratio, such as yard waste, animal manure or sewage sludge.

Soils in landscapes surrounding new homes and other buildings are often nutrient deficient with little organic matter because topsoil is removed and soil profiles are inverted during construction. We've shown that mulching with composted yard waste decreases soil compaction while increasing organic matter, microbial biomass, nutrient availability, and plant growth. Yet, ironically, yard trimmings are often collected and removed from ornamental landscapes. Composting them instead for use as mulch offers great potential for rehabilitating degraded soils, while diverting a valuable natural resource from landfills.

Acknowledgments

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Literature Cited

Attiwell, P. M., and M. A. Adams. 1993. Nutrient cycling in forests. *New Phytologist* 124: 561-582.

Facelli, J. M., and S. T. A. Pickett. 1991. Plant litter: its dynamics and effects on plant community structure. *Botanical Review* 57:1-32.

Frey, S. D., E. T. Elliott, K. Paustian, G. A. Peterson. 2000. Fungal translocation as a mechanism for soil nitrogen inputs to surface residue decomposition in a no-tillage agroecosystem. *Soil Biology and Biochemistry* 32:689-698.

Glenn, J. 1999. Producers expand line of mulch products. *BioCycle* 40:45-47.

Kaye, J. P., and S. C. Hart. 1997. Competition for nitrogen between plants and soil microorganisms. *Trends in Ecology and Evolution* 12: 139-142.

Mary, B., S. Recous, D. Darwis, and D. Robin. 1996. Interactions between decomposition of plant residues and nitrogen cycling in soil. *Plant and Soil* 181: 71-82.

McKeever, D. B. 1999. How woody residuals are recycled in the United States. *BioCycle* 40: 33-44.

Nasholm, T., A. Ekblad, A. Nordin, R. Giesler, M. Högberg, and P. Högberg. 1998. Boreal forest plants take up organic nitrogen. *Nature* 392:914-916.

Nasholm, T., K. Huss-Danell, and P. Högberg. 2000. Uptake of organic nitrogen in the field by four agriculturally important plant species. *Ecology* 81:1155-1161.

Robinson, D. W. 1988. Mulches and herbicides in ornamental plantings. *HortScience* 23:547-552.

Wardle, D. A. 1992. A comparative assessment of factors which influence microbial biomass carbon and nitrogen levels in soil. *Biological Review* 67:321-358.

Apple Scab on Crabapples at Secrest Arboretum: 2001

James A. Chatfield, Erik A. Draper, Daniel A. Herms, and Kenneth D. Cochran

Introduction

Apple scab pressure was high at the Secrest Arboretum of the Ohio Agricultural Research and Development Center (OARDC) of the Ohio State University in 2001. Yet, even under this considerable disease pressure, 20 of the 63 taxa showed no evidence of apple scab in 2001 and a total of 30 never received a rating that exceeded 1 (no aesthetic impact) on any evaluation date. Twenty-one taxa received a rating of 3 or higher on at least one date in 2001, indicating substantial defoliation and aesthetic impact (Table 1 on page 95).

Materials and Methods

Sixty three crabapple taxa were planted in 1997-1998 at the Secrest Arboretum of OARDC (Wooster, Ohio) in a completely randomized design. There were five replicate plants for each taxa with the exception of 'Brandywine,' 'Canary,' 'Dolgo,' 'Indian Magic,' 'King Arthur,' and 'Royal Scepter,' for which there were four replicates, and 'Hamlet,' for which there were three.

Plants were mulched with composted yard waste and irrigated as needed during the year of transplanting. Weeds were controlled with spot applications of glyphosate.

On June 13, July 9, August 2, and September 19, 2001, all trees were rated on a scale of 0 to 5, with 0 = no scab observed; 1 = less than 5% of leaves affected and no aesthetic impact; 2 = 5 to 20% of leaves affected, with some yellowing but little or no defoliation, moderate aesthetic impact; 3 = 20 to 50% of leaves affected, significant defoliation and/or leaf yellowing, substantial aesthetic impact; 4 = 50 to 80% of leaves affected, severe foliar discoloration and defoliation, severe aesthetic impact; and 5 = 80 to 100% of foliage affected, with 90 to 100% defoliation.

Results and Discussion

Apple scab ratings of crabapples at Secrest Arboretum for the 2001 season are presented in Table 1. Following are key findings.

1. A third of the crabapple taxa in the plot exhibited significant defoliation and substantial negative aesthetic effect in 2001 (Table 1 on page 95).

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2. Despite this level of scab pressure, nearly a third of the crabapple taxa in the plot exhibited no apple scab incidence in 2001 (Table 1). Furthermore, nearly half of the crabapples in the plot did not exhibit aesthetic impact from apple scab in 2001. This data, coupled with similar data from previous years, suggests that landscape managers have the option of selecting a wide palette of crabapples with little or no scab problems.

3. For the second year in row, 'Prairifire' crabapple did exhibit some scab in the plot, though it was minor. This is of some concern because scab was not seen on 'Prairifire' for several decades in the current and former plots at Secrest Arboretum. Though the level of scab was minor on 'Prairifire,' its presence in 2000 and 2001 raises the question of whether there is a new race of the apple scab fungus (*Venturia inaequalis*) in the arboretum.

References

1. Chatfield, J. A., E. A. Draper, K. D. Cochran, and Daniel A. Herms. 2001. Evaluation of crabapples for apple scab at the Secrest Arboretum in Wooster, Ohio: 2000. The Ohio State University, Ohio Agricultural Research and Development Center. Special Circular 177. *Ornamental Plants: Annual Reports and Research Reviews, 2000.* pp. 87–90.

2. Chatfield, J. A., E. A. Draper, K. D. Cochran, P. W. Bristol, and C. F. Tubesing. 2000. Evaluation of crabapples for apple scab at the Secrest Arboretum in Wooster, Ohio: 1999. The Ohio State University, Ohio Agricultural Research and Development Center. Special Circular 173. *Ornamental Plants: Annual Reports and Research Reviews, 1999.* pp. 83–87.

3. Chatfield, J. A., E. A. Draper, and K. D. Cochran. 1996. Comprehensive aesthetic evaluations of crabapples in Ohio: 1993–1995. *Malus: International Ornamental Crabapple Bulletin* 10(1) 5–16.

4. Chatfield, J. A., E. A. Draper, K. D. Cochran, P. W. Bristol, and D. E. Allen. 1998. Comprehensive Evaluations of Crabapples at Secrest Arboretum in Wooster: 1993–1998. The Ohio State University, Ohio Agricultural Research and Development Center. Special Circular 162. *Ornamental Plants: Research Reports and Extension Summaries, 1998.* pp. 94–104.

Table 1. Apple Scab at Secrest Arboretum in Wooster, Ohio, in 2001.

Crabapple Taxon	Sept 19	Aug 2	July 9	June 13
'Adirondack'	0.00 a *	0.00 a	0.00 a	0.00 a
'Bob White'	0.00 a **	0.00 a	0.00 a	0.00 a
'Camelot'	0.00a	0.00a	0.00a	0.00a
'Callaway'	0.00a	0.00a	0.00a	0.00a
'Canterbury'	0.00a	0.00a	0.00a	0.00a
'Dolgo'	0.00a	0.00a	0.00a	0.00a
'Excalibur'	0.40ab	0.00a	0.00a	0.00a
'Firebird'	0.00a	0.00a	0.00a	0.00a
'Foxfire'	0.00a	0.00a	0.00a	0.00a
'Golden Raindrops'	0.00a	0.00a	0.00a	0.00a
'Guinevere'	0.00a	0.00a	0.00a	0.00a
'Hamlet'	0.00a	0.00a	0.00a	0.00a
'Holiday Gold'	0.20ab	0.00a	0.25ab	0.00a
'Jackii'	0.00a	0.00a	0.00a	0.00a
'King Arthur'	0.50ab	0.00a	0.00a	0.00a
'Lollipop'	0.00a	0.00a	0.00a	0.00a
'Louisa'	0.00a	0.00a	0.00a	0.00a
'Prairie Maid'	0.00a	0.00a	0.00a	0.00a
'Purple Prince'	0.00a	1.00b	0.50	0.00a
'Rawhide'	0.00a	0.00a	0.00a	0.00a
'Silver Moon'	0.00a	0.00a	0.00a	0.00a
'Sinai Fire'	0.00a	0.00a	0.60bcd	0.00a
'Strawberry Parfait'	0.00a	0.00a	0.00a	0.00a
'Tina'	0.00a	0.00a	0.00a	0.00a
M. sargentii	0.00a	0.00a	0.00a	0.00a
'Brandywine'	3.50mn	2.25de	1.60fg	2.00f
'Prairifire'	0.60bc	0.60b	0.80cde	0.00a
'Cinderella'	1.60ef	0.00a	1.00de	1.00bc
'Candymint'	0.20ab	0.60b	0.20ab	0.00a
'Coralburst'	2.00fgh	2.00cd	2.40ijk	1.40cde
'David'	1.00cd	1.00b	0.80de	0.75b
'Lancelot'	1.00cd	1.00b	0.40abc	0.00a
'Pink Princess'	1.40ef	1.00b	0.60bcd	0.00a
'Red Jewel'	0.60bc	0.80b	0.25ab	0.00a
'Manbeck Weeper'	1.60ef	1.80c	1.20ef	1.00bc
M. floribunda	2.25ghi	2.00cd	1.80gh	1.80ef
'Professor Sprenger'	2.75jkl	2.75fg	1.00de	1.50de
'Mary Potter'	2.00fgh	2.40def	1.00de	1.80ef
'Sugar Tyme'	2.40ijk	2.00cd	1.80gh	1.40cde
'Donald Wyman'	2.75jkl	2.00cd	2.00ghi	3.00g
'Doubloons'	3.60nm	3.00gh	1.80gh	1.60def

Table 1. Apple Scab at Secrest Arboretum in Wooster, Ohio, in 2001.

Crabapple Taxon	Sept 19	Aug 2	July 9	June 13
'Molten Lava'	2.20ghi	2.40def	1.00de	1.00bc
'American Salute'	3.20lm	3.00gh	1.80gh	2.00f
'Canary'	3.00kl	3.00gh	1.80gh	2.00f
'Sentinel'	1.80efg	2.00cd	1.20ef	1.00bc
'Adams'	3.00kl	3.00gh	2.60ijk	2.60g
'Red Splendor'	2.60hij	2.60efg	1.60fg	1.00bc
'Royal Fountain'	3.00kl	2.80fgh	2.00ghi	2.00f
'Silver Drift'	3.00kl	2.40def	2.00ghi	2.00f
'Snowdrift'	4.20op	3.00gh	2.20hij	2.00f
'American Spirit'	3.20lm	3.00gh	3.00l	2.00f
'Royal Scepter'	4.75q	3.20hi	2.00ghi	1.60def
'Red Jade'	2.20ghi	2.40def	1.00de	1.50de
'American Masterpiece'	4.80q	3.60ij	3.00l	2.00f
'Harvest Gold'	3.60nm	3.00gh	3.00l	2.00f
'Jewel Berry'	4.20op	3.20hi	3.00l	2.00f
'White Cascade'	4.80 q	3.00gh	3.00l	2.00f
'Pink Satin'	4.60pq	4.00j	3.00l	2.00f
'Spring Snow'	4.00no	2.80fgh	2.00ghi	2.00f
'Weeping Candied Apple'	4.80q	4.00j	3.75m	3.00g
'American Triumph'	5.00q	3.40ij	2.60jk	2.00f
'Indian Magic'	4.75q	3.00gh	3.00l	1.50de
'Thunderchild'	3.00kl	2.60efg	1.80gh	1.20cd
Grand Mean	1.74	1.47	1.12	0.93
LSD			0.47	
0.42	0.47		0.44	

* 0 = no scab observed; 1 = less than 5% of leaves affected and no aesthetic impact; 2 = 5 to 20% of leaves affected, with some yellowing but little or no defoliation, moderate aesthetic impact; 3 = 20 to 50% of leaves affected, significant defoliation and / or leaf yellowing, substantial aesthetic impact; 4 = 50 to 80% of leaves affected, severe foliar discoloration and defoliation, severe aesthetic impact; and 5 = 80 to 100% of foliage affected, with 90 to 100% defoliation.

** Means in a column with the same letter are not significantly different (LSD test, $p<0.05$).

Tackling Heat Stress in Container Stock

Hannah Mathers

The prime biological advantage of container stock over bare-root stock is that the root system is packaged and protected from transplant or mechanical stress. However, cultivar differences in susceptibility to winter injury (Colombo *et al.*, 1984; Johnson and Havis, 1977) and summer injury (Ranney and Peet 1994; Jull *et al.*, 1999) in container-produced stock have been reported (Colombo *et al.*, 1984; Johnson and Havis, 1977). Responses of cultivars to different cultural practices could help us determine methods of predicting the factors that influence root and shoot hardiness and help reduce winter and summer root kill in container nursery production.

With increased production of container-grown nursery crops, root hardiness has become the most important factor determining winter (Johnson and Havis, 1977) and summer (Sibley *et al.*, 1999) survival. Commercial distribution in horticultural crops is usually limited by inadequate top-growth hardiness. However, limits in the commercial range of ornamental production are becoming associated directly or indirectly with lack of root hardiness in winter and lack of heat tolerance of roots in summer. Nursery growers are very interested in knowing more about root winter hardiness and summer root heat tolerance levels, and how to reduce winter and summer root kill in container production.

Lyr and Hoffmann (1967) proposed that the hardiness of shoots is of little importance in determining the natural tree line in northern regions. They suggested that the real factor determining site tolerance for a species is soil temperature. Insufficient root activity as a consequence of low soil temperature would limit northern growth, because plants suffer from desiccation due to high transpiration and limited water uptake.

Heat stress can also be a major limiting factor in the distribution, adaptability, and productivity of wild and cultivated plants. Inhibition of growth or plant decline under supra-optimal temperatures can result from thermal effects on many physiological and developmental processes (Fitter and Hay, 1987). Net photosynthesis (Pn), in particular, is one of the most heat-sensitive processes that govern plant growth (Ranney and Peet, 1994). Heat stress has been shown to be a major limiting factor for plant production and adaptability in containers (Sibley *et al.*, 1999). Seedlings are especially susceptible to high temperature stress (Columbo and Timmer, 1992).

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Abiotic Stresses

Nurseries that produce high-quality nursery stock usually have a strong nursery monitoring program in place. One important part of a nursery monitoring program is to know how to submit a good sample for outside consultations and/or confirmations. When you submit samples to a plant diagnostic laboratory, the expected outcome is a confirmation or refutation of the presence of an infectious disease. Infectious diseases are often referred to as biotic disorders, meaning the causal organism is alive. Sixty percent or more, however, of what is presented to most diagnostic laboratories is abiotic in origin. Abiotic means the causal organism is not alive.

Being able to determine the difference between abiotic disorders and biotic infections in the field is not always easy. Sometimes submitting a sample to the diagnostic laboratory is a good idea even when you are quite sure the primary cause of the problem is abiotic. In some situations, secondary pathogenic invaders may come in after an abiotic injury, and you may want to ensure that you're not missing something that will cause problems later.

Some common non-infectious or abiotic disorders are physiological disorders like graft incompatibility, chemical injuries due to pesticide applications, nutritional deficiencies or excesses, excess light or shading, planting problems, flooding, drought, or salt damage. Mechanical injury due to wind, ice, or other physical factors such as mowers or pollution injuries are also common abiotic problems. Temperature extremes, either too high or too low, are a predominant cause of container abiotic injuries.

Heat Shock Proteins

Heat Shock Proteins (HSPs) form in response to many of the abiotic stresses outlined earlier, including high and low temperatures (Waters *et al.*, 1996); osmotic or salt stress; arsenic; anaerobic conditions; high ABA concentrations; high ethylene levels; high auxin levels; and drought (Vierling, 1991). HSPs belong to a larger group of molecules called chaperones, which have a role in stabilizing other proteins. Low molecular weight HSPs are generally produced only in response to environmental stress and little was known about their function (Howarth and Ougham, 1993) until 1998.

Heckathorn *et al.* (1998) found that HSPs are involved in protecting Photosystem II during exposure to high temperatures. Heckathorn *et al.* (1998) showed that whole-chain electron transport was greater in pre-heat-stressed plants relative to controls at 117ºF which indicates that acclimation to high temperatures occurred in pre-heat-stressed plants. This acclimation appeared to be entirely the result of production of low molecular weight HSPs.

High root-zone temperatures have a profound effect on plant growth. Root growth is retarded at temperatures greater than 30ºC or 86ºF. Root growth in many woody species stops at temperatures exceeding 40ºC or 103ºF (Johnson and Ingram, 1984). Cessation of top growth and shoot necrosis also occurs at these temperatures. High root-zone temperatures can result in decreases in photosynthesis. HSPs are involved in protecting Photosystem II during heat stress (Heckathorn *et al.*, 1998).

Different species within genera have different tolerances to heat (Ranney and Peet, 1994), and different seed provenances within taxa have different heat tolerances. Provenance refers to the geographic origin of the seed. Root zone temperatures of 50ºC or 121ºF occur in Florida containers (Ruter, 1989), and 122ºF is reported in Oregon (Svenson, personal communication, 2000). Conventional containers in South Carolina commonly reached highs of 90 to 95ºF and can reach 110ºF in the center (London *et al.*, 1998). Temperatures as high as 137ºF have been recorded in southern states (Martin and Ingram, 1988, and Ruter, 1997a). Normal root functioning ceases when root zone temperatures exceed 96ºF for holly (Ruter and Ingram, 1992) and at even lower temperatures, approximately 90ºF for less heat tolerant plants (Levitt, 1979). Media highs of 138ºF are also reached in Ohio in the center of one-gallon containers on gravel beds (Struve, personal communications, 2001).

The importance of keeping container substrate temperatures below 100ºF is well documented; however, as mentioned earlier, high substrate temperatures in above-ground containers in Florida and other states are not uncommon. *Thuja occidentalis, Euonymus alatus,* and *Hosta* spp. are particularly sensitive to high root temperatures. *Picea glauca* 'Conica,' the dwarf Alberta spruce, can be sensitive to high root zone temperatures when they are first spaced out in the spring, due to the narrow pyramidal habit of the plant. An even browning of foliage over the crown is one way root burn is expressed in Alberta spruce. In above-ground containers, the roots in the western quadrant of the container are often injured or killed by high temperatures.

In Pot-In-Pot (PIP) systems, roots in the western quadrant were 23ºF cooler than in above-ground pots (Ruter, 1997b). In the PIP production system, a planted container is placed in a holder pot that has been permanently placed in the ground. PIP was first started in the southern states to protect roots from extreme summer temperatures but really caught on in northern states because of the advantages in winter protection. Plants grown in PIP had 20% more top growth and nearly twice the root mass compared to conventional container-grown plants due to the protection provided from high temperature extremes.

Recently Fuchigami and Cheng (1999) emphasized that plants must be able to photosynthesize and maintain optimum chlorophyll levels to ensure optimum growth and plant health. Plants that experienced high root-zone temperatures suffered loss of chlorophyll and protein production in shoots (Kuroyanagi and Paulsen, 1988). Research indicates this has a significant impact on overall plant health (Ruter and Ingram, 1992).

Other Factors Regarding Heat Stress

The ability to absorb nutrients is also an important component of plant adaptation. Plants also have an ideal temperature range for optimum absorption of mineral nutrients (Pisek *et al.*, 1973).

Calcium (Ca) has been found to increase heat tolerance in plants (Bakanova, 1970). However, improper overwintering and supra-optimal root-zone temperatures can cause Ca deficiencies. Only young root tips in which the cell walls are still unsuberized can absorb calcium. Calcium is required for cell division and elongation. Injury to young roots can result in a "Catch 22" in nursery culture. Young roots are required for Ca uptake; however, Ca is necessary for young root formation. Once young roots are injured, it is hard to correct the problem.

Young plants require higher levels of available nutrients relative to older plants. Young plants have the highest nutrient requirements per unit of root system, and nutrient deficiencies are more common with young plants.

Mineralization *(e.g.,* conversion of organic Nitrogen [N] to inorganic N) of composted container substrates is also affected by high temperatures (Kraus *et al.*, 2000). Both nitrate ($N0_3^-$) and ammonium (NH_4^+) are inorganic forms of N that can be taken up and metabolized by plants.

Nitrate is often a preferential source for plants but much depends on the plant species and other environmental factors. A number of reports indicate that the uptake of both N-forms is temperature dependent, with rates of uptake being depressed by lower temperatures (Clarkson and Warner, 1979).

In general, composts are considered valuable amendments for container substrates. However, most nutrients in compost are not readily soluble and are only released as the organic material breaks down. Most of the N mineralization studies have been conducted at soil temperatures found in field production. Mineralization of organic N is microbially mediated, and the rate of nutrient availability is regulated by environmental conditions such as temperature, moisture, and pH (Haynes, 1986).

Since temperatures of container substrates can reach 103ºF and above, mineralization rates under these conditions will be quite different from field conditions. Kraus *et al.* (2000) found that the mineralization rates of certain composted materials in the first weeks of production were too rapid to support adequate N to maximize growth over the container production season. In recent studies, we have found that compost-containing media improves plant survival at high temperatures vs. traditional bark-based media (Johansen and Mathers, 2002).

Fiber pots, used in the nursery industry for years, especially for seasonal, bare-root crops, have recently had copper-based fungicides added to them for increased pot longevity. Fiber pots have many advantages, one being cooling effects for root systems. Overheating in black plastic containers occurs because of the large influx of energy from the sun combined with insufficient loss of the incoming heat. Due to high temperatures, the membrane integrity of the root is lost, and the roots are injured or killed (Larcher, 1995). Conventional plastic containers act as "black heat-sinks" whereas fiber pots do not (Ruter, 1999). Fiber pots also allow for evaporative cooling through their sides. With fiber containers, some of the absorbed heat is dissipated enough that supra-optimal root-zone temperatures are avoided (Beattie *et al.*, 1999). Fiber pots, due to their porous-walls, also increased air exchange throughout the depth of the container, which improves root development by decreasing the potential for waterlogging (Ruter, 1999).

Conclusions

Soil temperature is a very important factor in the growing of woody plants. A plant cannot be any hardier than its roots. If the roots are unable to endure the temperatures to which they are subjected, the plant cannot survive no matter the hardiness of the above-ground plant parts (Patterson, 1936). Many studies of root cold hardiness of numerous woody plants have demonstrated that the root system is substantially less hardy than that of the shoot system (Weist and Steponkus, 1977). Much of the death above ground that occurs in woody plants, especially in containers, is doubtless the result of root death and of the destruction of many of the absorbing organs of the plant.

Mityga and Lanphear (1971) proposed that only mature roots could harden off to freezing temperatures because the high levels of gibberellic acid produced in root tips of the young roots nullified the effect of the growth regulator. Root cold hardiness studies generally indicate that mature root hardiness values are several degrees lower than for the young roots. In many cases, mature roots may survive even when young roots are killed. This explains, however, why some plants flush much later than normal in the spring, show retarded growth throughout the growing season, and may become susceptible to root rot or other disease pathogens. Overwintering practices need to be sufficient to protect mature and young roots from injury. The influence of root maturity has not been studied for high temperature stress.

There are many things that need to be researched in the area of temperature disorders and ornamental culture. However, good container media and nutrition management is basic to the production of quality container-grown plants (Davidson *et al.*, 1988). To minimize environmental impact, many growers are using controlled-release fertilizers (CRFs) and composted materials. High levels of nitrogen have been shown to inhibit both dormancy and cold hardiness. Nielsen (1974) indicated adjustments in amount of water and nutrients supplied could partially ameliorate the affects of unfavorable root-zone temperature. However, Yeager *et al.* (1991) showed a threshold point was passed at 103ºF. At temperatures above 103ºF, nitrogen accumulation decreased regardless of nitrogen application rate. Although research indicates that supplemental fertilizing with water-soluble fertilizers, particularly nitrogen, is beneficial for fast-growing crops when using CRFs and that composts are good soil amendments for physical properties in containers, the effects of fertilizer regimes on dormancy induction, cold hardiness of roots and shoots, and high temperature tolerance have not been sufficiently examined.

References

Bakanova, L. V. 1970. Relative heat resistance of leaves and spikelet glumes of certain cereal plants. *Soviet Plant Physiol.* 17: 109-113.

Beattie, D. J., R. Berghage, V. Puri, and E. Biddinger. 1999. Plant growth thrives on a high-fiber diet. *Nursery Management & Production.* 15(3): 81-83.

Clarkson, D. T. and A. J. Warner. 1979. Relationships between air temperature and transport of ammonium and nitrate ions by Italian and perennial ryegrass. *Plant Physiol.* 64: 557-561.

Columbo, S. J. and V. R. Timmer. 1992. Limits of tolerance to high temperature causing direct and indirect damage to black spruce. *Tree Physiol.* 11: 95-104.

Davidson, H., R. Mecklenburg, and C. Peterson. 1988. *Nursery Management Administration and Culture.* Prentice Hall, N.J.

Fitter, A. H. and R. K. M. Hay. 1987. *Environmental Physiology of Plants.* 2nd Ed. Academic Press, London.

Fuchigami, L. and Cheng, L. 1999. Ornamentals Northwest Seminars, Portland, Ore. (Handout).

Haynes, R. L. 1986. *Mineral nitrogen in the plant-soil system.* Academic Press, Orlando, Fla.

Heckathorn, S. A. C. A. Downs, T. D. Sharkey, and J. S. Coleman. 1998 The small, methionine-rich chloroplast heat-shock protein protects Photosystem II electron transport during heat stress. *Plant Physiol* 116: 439-444.

Howarth, C. J. and H. J. Ougham. 1993. Gene expression under temperature stress. *New Phytol* 125: 1-26.

Johnson, J. R. and J. R. Havis. 1977. Photoperiod and temperature effects on root acclimation. *J. Am. Soc. Hort. Sci.* 102:306-308.

Jull, L. G., T. G. Ranney, and F. A. Blazich. 1999. Heat tolerance of selected provenances of Atlantic White Cedar. *J. Am. Soc. Hort. Sci.* 124:492-497.

Kraus, H. T., Mikkelsen, R. L. and S. L. Warren. 2000. Container substrate temperatures affect mineralization of composts. *HortScience* 35: 16-18.

Kuroyanagi, T. and G. M. Paulsen. 1988. Mediation of high-temperature injury by roots and shoots during reproductive growth of wheat. *Plant Cell Environ.* 11:517-523.

Levitt, J. 1979. *Responses of Plants to Environmental Stresses.* Vol. 1. Academic Press, N.Y.

London, J. B., R. T. Fernandez, R. E. Young, and J. D. Christenbury. 1998. Media temperatures in above-ground and in-ground pot-in-pot container systems. *HortScience* 33:512 (Abstr.).

Lyr, H. and G. Hoffmann. 1967. Growth rates and growth periodicity of tree roots. *Int. Rev. For. Res.* 2:181-236.

Martin, C. A. and D. L. Ingram. 1988. Temperature dynamics in black poly containers. *Proc. Southern Nurserymen's Assoc. Res. Conf.* 33: 71-74.

Mityga, H. G. and F. O. Lanphear. 1971. Factors influencing the cold hardiness of *Taxus cuspidata* roots. *J. Am. Soc. Hort. Sci.* 96:83-86.

Nielsen, K. F. 1974. Roots and root temperatures. pp. 293-333. In: E. W. Carson, Ed. *Plant root and its environment.* Univ. of Virginia Press, Charlottesville.

Patterson, C. F. 1936. *Hardy fruits: With special reference to their culture in western Canada.* 1st Ed. R. and R. Clark, Ltd., Edinburgh, England.

Pisek, A., W. Larcher, A. Vegis, and K. Napp-Zinn. 1973. The normal temperature range. pp. 102-194. In: H. Precht, J. Christophersen, H. Hensel, and W. Larcher, Eds. *Temperature and life.* Springer-Verlag, New York.

Ranney, T. G. and M. M. Peet. 1994. Heat tolerance of five taxa of Birch *(Betula):* physiological responses to supraoptimal leaf temperatures. *J. Am. Soc. Hort. Sci.* 119:243-248.

Ruter, J. M. 1989. Physiological and biochemical responses of *Ilex crenata* 'Rotundifolia' to supraoptimal root-zone temperatures. Ph.D. Dissertation. Univ. of Florida, Gainesville.

Ruter, J. M. 1994. Evaluation of Control Strategies for Reducing Rooting Out Problems in Pot-In-Pot Production Systems. *J. Environ. Hort.* 12(1):51-54.

Ruter, J. M. 1995. Growth of Southern Magnolia in Pot-in-Pot and Above-Ground Production Systems. *Proc. Southern Nurserymen's Assoc. Res. Conf.* 40: 138-139.

Ruter, J. M. 1997a. Evaluation of Tex-R Agroliners for Bag-in-Pot Production. *Proc. Southern Nurserymen's Assoc. Res. Conf.* 42: 162-164.

Ruter, J. M. 1997b. The Practicality of Pot-In-Pot. *American Nurseryman* 8(2): 32-37.

Ruter, J. M. 1998. Production of 'Rotundiloba' Sweetgum Using Tex-R Agroliners. *Proc. Southern Nurserymen's Assoc. Res. Conf.* 43: 59-61.

Ruter, J. M. 1999. Fiber pots improve survival of 'Otto Luyken' Laurel. *Proc. Southern Nurserymen's Assoc. Res. Conf.* 44: 53-54.

Ruter, J. M., Ingram, D. L. 1992. High Root-zone Temperatures Influence RuBisCo Activity and Pigment Accumulation in Leaves of 'Rotundifolia' Holly. *J. Amer. Soc. Hort. Sci.* 117(1):154-157.

Sibley, J. L, J. M. Ruter, and D. J. Eakes. 1999. High temperature tolerance of roots of container-grown red maple cultivars. *Proc. Southern Nurserymen's Assoc. Res. Conf.* 44: 24-28.

Vierling, E. 1991. The roles of heat shock proteins in plants. *Ann. Rev. Plant Physiol. Plant Mol. Biol.* 42:579-620.

Waters E. R., G. J. Lee, and E. Vierling. 1996. Evolution, structure, and function of the small heat shock proteins in plants. *J. Exp. Bot.* 47: 325-338.

Weist, S. C. and P. L. Steponkus. 1977. Accumulation of sugars and plasmalemma alterations: Factors related to lack of cold acclimation in young roots. *J. Am. Soc. Hort. Sci.* 102:119-123.

Yeager, T. H., R. H. Harrison and D. L. Ingram. 1991. 'Rotundifolia' Holly growth and nitrogen accumulation influenced by supraoptimal root-zone temperatures. *HortScience* 26:1387-1388.

Gypsy Moth Update

William Pound, Amy K. Stone, Daniel A. Herms, David J. Shetlar, and Kelly Harvey

Summary

Introduction

The gypsy moth, *Lymantria dispar* L., is one of the most notorious pests of hardwood trees in the eastern and Midwestern United States and continues to increase its range. The gypsy moth is a nonnative insect, introduced into the United States in 1869 by a French scientist living in Massachusetts. The first outbreak occurred in 1889. By 1987, the gypsy moth had established itself throughout the Northeast.

The first male gypsy moth was captured in northeastern Ohio in 1971, with the first defoliation in the state occurring in 1990. The gypsy moth has colonized Ohio on two fronts, spreading from Pennsylvania in the east and from Michigan in the northwest. Currently, the frontal boundary of the gypsy moth infestation in the United States is located roughly on a line extending from north central Wisconsin through central Ohio and extending into southern Virginia.

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Figure 1. Gypsy moth-quarantined counties in Ohio, 2001.

In Ohio, 42 counties contain established populations of this pest and are quarantined (Figure 1).

Life Cycle and Biology

The gypsy moth life cycle begins with hatching of the eggs located within the egg mass. In Ohio, spring weather governs the timing of egg hatch, but it generally begins between April 15 to 20 each year. The young caterpillars (larvae) are black and approximately 1/8-inch long. The young caterpillars cluster on the egg mass for seven to 10 days, then disperse upward in the trees and begin feeding on the expanding foliage. During the next six to eight weeks, the larvae feed and undergo four to five developmental changes. Feeding during these latter developmental instars is when most of the leaf damage and defoliation occurs. The mature fifth- and sixth-instar caterpillars will be approximately 2 to 2.5 inches long.

Gypsy moth larvae are not the only caterpillars found in Ohio's trees. Fortunately, the identification of the gypsy moth caterpillars is simplified by the presence of 11 pairs of colored dots. Beginning at the head capsule, the first five pairs are blue, the last six pairs are brick red in coloration. No other forest insect pest in Ohio exhibits this pattern or coloration.

Approximately seven to eight weeks after egg hatch (mid June), the caterpillars transition into the pupal (resting) stage. Ten to 14 days later the adult moths emerge. The adult male moths emerge first and are distinguishable by their feathery, plumose, antennae and brown coloration. They depend on these antennae to locate the pheromone scent of the females. The female moths are white, larger, and emerge later than the males. The female moths do not fly. Therefore, successful mating is dependant on the male finding the female.

Neither of the adult moths feed, but simply live off their food reserves long enough to mate and for the female to lay an egg mass. The egg masses are laid in dense masses of brownish-tan, hairlike scales. Egg masses can contain more than 1,000 eggs with most egg masses containing 100 to 300 eggs. In Ohio, the laying of egg masses completes the life cycle and is usually accomplished by mid-late July or early August. For the next eight to nine months, the integrity of the egg masses protect and preserve the eggs.

Within the pests' annual life cycle, the damage to trees is initially due to the feeding of the larval stage of the gypsy moth, resulting in defoliation of the trees. Once defoliation occurs, the natural response of the affected trees is to refoliate and send out a new flush of leaves. This process depletes energy reserves and serves to weaken the health of the trees. Consecutive years of heavy defoliation eventually depletes tree reserves and often results in the death of the trees. Initially, the control strategy is focused on an integrated pest management (IPM) approach to suppress populations of the gypsy moth.

The foundation of IPM programs is the reliance on natural controls to reduce gypsy moth feeding and subsequent defoliation and tree loss. Unfortunately, gypsy moth is a nonnative insect and has very few natural controls. The populations of this insect can build very quickly and outpace corresponding increases in populations of these natural controls.

In wooded residential and forested areas where the gypsy moth has already defoliated target trees or is currently supporting populations capable of defoliating trees, the control programs should be selective aerial applications or ground applications capable of delivering recommended control products to the tops of the trees where active larval feeding is occurring. Treatments are most effective when applications are made to young larvae and after all eggs have hatched. In Ohio this is usually early May.

Insect Feeding Damage

Susceptibility of a forested area to gypsy moth damage will depend largely on the composition of species within the wooded area. Gypsy moths can feed on the leaves of more than 500 species of trees and shrubs. The intensity of the infestation will often influence which tree species are at risk.

Generally, the trees most at risk include many of the oak species, particularly the white oak, aspen, grey and paper birch, larch, and apple. Tree species generally resistant to gypsy moth include yellow poplar, honey locust, red maple, silver maple, white ash, and dogwood.

Management Strategies

There is no "silver bullet" for dealing with gypsy moth. Successful management requires an integrated approach based on a number of techniques. When population densities are high, the safest and most effective tool for preventing widespread defoliation is aerial applications of an insecticide derived from the naturally occurring bacterium, *Bacillus thuringiensis*, commonly known as *Bt*.

In regions where gypsy moth has been established for a number of years, natural controls help keep the populations in check during most years. Natural enemies include insect parasites that attack egg and caterpillar stages, predators such as birds, and disease organisms.

Gypsy moth is especially susceptible to a virus, NPV (nucleopolyhedrosis virus), that is often responsible for the crash of high populations. A fungal disease of gypsy moth caused by *Entomophaga maimaiga* has been introduced into Ohio and is a promising tool for gypsy moth management.

State Gypsy Moth Management Programs

The Ohio Department of Agriculture (ODA) administers the state Gypsy Moth Management Program for the forested areas within Ohio. The primary responsibilities of this program are two-fold. First, in the Ohio counties where the pest is already established *(i.e.,* quarantined counties), the ODA administers the Suppression Program. Through joint funding with the USDA Forest Service and the state of Ohio, this program coordinates aerial treatments of woodland areas at risk to damage from the feeding of the gypsy moth caterpillars. The objective of treatments applied through this program is to prevent defoliation of the trees. Control products utilized in the 2001 program included *Bt,* Dimilin, and Gypchek. Participation in the ODA Suppression program is voluntary, and interested individuals are required to complete an application by Sept. 15 of the year preceding the treatments. Currently, 42 of Ohio's 88 counties contain established gypsy moth populations and qualify for participation in the Suppression Program.

In the summer of 2000, 23,294 acres of forested private, state, and federal lands were defoliated by gypsy moth. In the fall and winter of 2000, field crews from the ODA conducted gypsy moth egg mass surveys on approximately 62,000 acres of forestland at the request of the landowners. The purpose of the survey was to estimate gypsy moth egg mass densities on a per acre basis, which is used to predict the amount of defoliation expected in 2001. Based on egg mass densities, a total of 37,662 acres in 19 counties were treated during the spring of 2001.

The second gypsy moth program coordinated through ODA is the Slow-The-Spread (STS) program. The primary objective of this program is to slow the movement of this pest across Ohio. This program relies on an extensive pheromone trapping program to detect and monitor gypsy moth populations. When populations are identified in the nonquarantined counties, these areas are potential candidates for either mating disruption treatments, control product treatments, or intensive trapping and further monitoring. The 46 Ohio counties currently not quarantined are being monitored through this program.

Ohio has participated in the STS program since 1999, along with North Carolina, Virginia, West Virginia, Kentucky, Indiana, Michigan, Illinois, and Wisconsin, and in cooperation with the USDA Forest Service. Pheromone flakes were applied aerially in 2001 on approximately 44,825 acres in Lawrence, Scioto, Ross, Pike, Clark, and Greene Counties of Ohio.

This summer, 45 seasonal employees deployed, monitored, and retrieved more than 13,277 pheromone traps for male gypsy moths. The traps were placed in all or part of 62 of the 88 counties in Ohio. The traps monitored population increases and territorial expansion of the range of the gypsy moth. Every dollar spent per year for STS activities saves four dollars in damage and management costs and reduces the spread of the gypsy moth range by 60% per year.

Conclusion

Public awareness, education, and information are essential components of any gypsy moth management program. This can be achieved by agencies and groups including Ohio State University Extension, the Ohio Forestry Association, Ohio Department of Natural Resources Division of Forestry, and the Ohio Department of Agriculture. These groups are working to raise the level of common knowledge of Ohio's citizens regarding the gypsy moth and the potential consequences this pest can inflict on Ohio's woodland environment.

Using Treeage

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Summary

Triage is a decision-making system used by emergency medicine practitioners to sort casualties into treatment categories. Limited time and resources are focused on treatable problems, rather than on problems that do not require treatment or that are non-treatable. This same decision-making system can be applied to managing plant problems. In that case, the name changes from Triage to Treeage. Treeage is a decision-making tool for selecting the best course of action. It provides a framework to help steer plant management decisions in a logical, common-sense direction. As such, it can help us to educate ourselves and our clientele as to why and when we need to "do something" or "do nothing."

Introduction

Plant pests, diseases, and cultural problems seldom conveniently occur in landscapes one at a time, as solitary events. Rather, landscape managers often face a number of plant problems inconveniently occurring simultaneously. Caterpillars may be consuming leaves at the same time lace bugs are stippling leaves, vascular wilt fungi are wilting leaves, fungi are causing branch cankers, galls are swelling, roots are rotting, and trees are collapsing from construction injury.

This collective onrush of plant problems may overwhelm landscape managers, causing them to function in a continual state of emergency. Rather than practicing plant health care, they execute critical care. Resources are taxed, and the decision-making process is impaired. Treatable plant problems go ignored while limited resources are focused on lost causes. This challenge is not unique to the plant health care industry, but how do we sort it all out?

Triage

Medical Triage (pronounced: trē-azh') was developed in the early 1800s by the French as a method to sort and prioritize the care of injured soldiers. The name is derived from the French "trier" meaning "to sort." Treating battlefield casualties on a first-come, first-served basis sometimes left the most seriously injured to die without medical care while the least injured received misplaced critical attention. The French demonstrated that by focusing limited medical resources using Triage, overall mortality rates could be substantially reduced. Triage has been adopted by the emergency medicine community throughout the world.

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There are several medical Triage systems, but the simplest rely on sorting patients into three categories.

- Category 1 — The patient will survive regardless of intervention efforts.
- Category 2 — The patient will not survive even with the application of the best available intervention efforts.
- Category 3 — The patient can survive with the application of intervention efforts.

Obviously, by using Triage, the greatest concentration of resources is properly expended on Category 3 patients.

Treeage

Triage focuses critical resources using a defined decision-making process. We believe this same process can benefit landscape managers. However, when directed toward plant problems, Triage becomes Treeage (also pronounced: tree-azh'.)

Treeage uses the same sorting categories as medical Triage, except "thrive" is added to "survive" in the predicted outcomes to reflect the need to practice plant health care. Each plant problem is examined, evaluated, and placed into one of three categories.

- Category 1 — The plant will survive and thrive without intervention efforts.
- Category 2 — The plant will not thrive, or survive, even with the application of the best available intervention efforts.
- Category 3 — The plant can survive and thrive if intervention efforts are focused on increasing plant health through pest management practices.

Discussion

Examples of Treeage Categories

Insect and mite galls provide good examples of Treeage Category 1 problems. Ash inflorescence galls are caused by the eriophyid mite, *Eriophyes fraxinivorus*. While these conspicuous brownish, lumpy, and unsightly galls look like small witches' brooms growing just beneath the leaves, only the flower parts are affected, so no real injury is done to the tree.

The bright red, globose, pouch-like bladder galls caused by the eriophyid mite, *Vasates quadripedes*, on the upper leaf surfaces of red and silver maples are another good example of a Category 1 mite gall problem.

There are more than 800 types of galls that may occur on oaks. However, only two are considered damaging to the host. Woolly leaf galls are a good example of a very apparent oak gall that causes no damage to the tree.

As its descriptive name implies, the woolly leaf gall looks like someone stuck a dense wad of light brown wool to a leaf vein. The galls are produced by the cynipid wasp, *Andricus fullawayi*, and are found on the underside of leaves where they are usually attached to the midvein, although they occasionally arise from lateral veins. They range in size from pea-sized to the diameter of a quarter.

When oak leaves turn color in the fall, the galls often detach and fall to the ground. Large numbers littering the ground beneath an oak tree may cause concern, but no harm has been done to the tree.

Tar spots are a good example of a Category 1 disease. In their book, *Diseases of Trees and Shrubs*, Sinclair, Lyon, and Johnson open their description of these diseases with the sentence, "Tar spots are among the most showy and least damaging foliar diseases." In summer, the fungus produces shiny, 1/4 to 1-inch diameter black spots on the upper leaf surface. The disease gets its name from the tar-like appearance of the spots. Indeed, as with many Category 1 pest problems, looks can be deceiving.

Dutch elm disease connects two beetles with fungi to produce a Treeage Category 2 problem. The native elm bark beetle, *Hylurgopinus rufipes*, and the European elm bark beetle, *Scolytus multistriatus*, are both capable of vectoring the fungi, *Ophiostoma ulmi* and *O. novoulmi*. These disease-causing fungi eventually cause xylem vessels to become incapable of transporting water. For almost all intents and purposes, once infected, American elms will die regardless of attempts to control or remove the infected parts.

Cultural problems may also be sorted into Treeage categories. A mature maple tree that has been badly "topped" and is in severe decline is a good example of a Category 2 problem — little can be done to restore the loss of vigor that usually follows this destructive pruning practice.

Eastern tent caterpillar (*Malacosoma americanum*) is a good example of a Category 3 problem. This insect shows-up early in the spring, produces webs between branch breaks, and feeds on newly expanding leaves. High populations of caterpillars can completely defoliate trees, requiring the tree to expend energy to refoliate.

Common bagworm (*Thyridopteryx ephemeraeformis*) is another Category 3 problem. Season-long feeding by this defoliator may strip needles and kill branches on conifers or entire trees. Both insects can be controlled with properly timed insecticide applications.

Shifting Treeage Categories

Treeage categories are not static. This is particularly true of Category 3 plant problems. In simplest terms, assigning a plant problem to Category 3 means that some action can and should be taken. However, Treeage practitioners should strive to select actions that ultimately move the problem out of Category 3 and into Category 1, where no action is necessary, or to address the plant problem in a way that the problem is completely eliminated. Conversely, if no action is taken, sometimes Category 3 problems may become Category 2 tragedies.

A young tree that is planted too deep should be placed in Treeage Category 3. The treatment is straight forward and needs to be applied only once — the tree should be excavated and replanted to the correct depth. Once this is accomplished, the problem is solved, and the tree is taken off the Treeage chart. However, if nothing is done, this Category 3 problem may eventually sink into the irretrievable realm of Category 2.

Apple scab on crabapple is clearly a Category 3 disease on susceptible varieties. If left alone, susceptible trees may become completely defoliated during years when fungal infection is heavy. Successive years of heavy defoliation may weaken trees. Multiple, properly timed applications of fungicides may suppress the problem, but a better long-term solution would be to select disease-resistant crabapple cultivars.

The availability of pest- and disease-resistant plant cultivars illustrates that certain pest-management solutions can be used to shift a problem from Category 3 into Category 1. Apple scab is a Category 1 problem on disease-resistant crabapple cultivars since nothing needs to be done.

A company's pest management capabilities can play a significant role in the placement of pest problems into certain categories. Remember that the definition of a Category 2 problem is that the plant will not thrive or survive with the application of the best available intervention efforts. The operative words are "best available." What if a company simply lacks the necessary equipment to successfully treat a particular problem? Not all hospital emergency rooms are equipped the same way, and some patients live or die based on this disparity in life-saving equipment.

Treeage Categories generally focus on plant health care. However, there remains the practical need to consider aesthetics. Fall webworm, *Hyphantria cunea*, envelops leaves in large silken nests, but on most landscape trees, their late season depredation causes little or no harm to the overall health of the tree. They are a Category 1 pest problem based on plant health care. However, if these nests should shroud the branches of a specimen weeping cherry tree, the customer will certainly want something to be done based on aesthetics. The pest problem shifts to Category 3.

Application of Plant Treeage

Treeage is a decision-making tool for selecting the best course of action. It provides a framework to help steer plant management decisions in a logical, common sense direction. As such, it can help us to educate ourselves and our clientele as to why and when we need to "do something" or "do nothing."

While it may seem desirable to produce a simple list of plant problems neatly classified into Treeage Categories, the examples of shifting categories illustrate that Treeage is a dynamic process. It should be viewed as an ever-developing "work in progress" guided by a company's needs, aspirations, and capabilities. Treeage empowers companies to combine their management capabilities with plant pest information to develop their own decision-making plans.

Treeage is connected to a well-know medical process popularized by a number of television shows, such as *M.A.S.H.* and *ER.* This connection provides an excellent frame of reference for communicating plant health-care decisions to clientele.

A company should make Treeage a topic of planning meetings. Staff members should think through what for them are the Category 1, 2, and 3 problems. Once a company establishes its Treeage Categories, then the staff can plan accordingly as to how they will institute Category 3 interventions or how they will limit their advertising claims and customer expectations for controlling Category 2 problems. They can also develop better communication methods with their customers to put Category 1 problems in the proper perspective.

Treeage and Integrated Pest Management (IPM)

Treeage is not intended to compete with or replace IPM. It should viewed as a companion to IPM programs for landscape plant pests. Indeed, in the same way that medical Triage is used to reduce the number of casualties that are advanced to the next stage of treatment, plant Treeage should be used before developing IPM programs, to limit the number of plant problems requiring further attention.

References

Boggs, J., J. Chatfield, and E. Draper. 2001. Performing Treeage. *American Nurseryman.* June 1, 2001. pp. 28-33.

Draper, E., J. Chatfield, and J. Boggs. 2001. Treeage: A Practical Plant Health Management Decision-Making Tool. *Arborist News.* Vol. 10, No. 3, October 2001. pp. 61-63.

No Less Sweet Because We Know Its Name

Martin F. Quigley, James A. Chatfield, and Kenneth D. Cochran

Knowing how plants are named is a critical skill for all horticulturists. As Michael Dirr notes in his useful notes on nomenclature in *Manual of Woody Landscape Plants*, "A name is a handle by which we get to know certain people, places, and plants." Plant names and the many nuances incorporated in those names help us get to know plants better.

The multiple common names of plants are often confusing. Toss in botanical Latin, and many plea to be spared the details. It brings to mind the old student lament of:

> *"Latin is a language,*
> *as dead as dead can be.*
> *First it killed the Romans:*
> *Now it's killing me."*

Confusion with names, however, is the very reason it is important to have a basic understanding of the naming systems for plants. As horticulturists, we want to avoid errors, to communicate properly to each other, to grow in our plant knowledge, and to enjoy the wonderful world of plants.

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When someone asks if a red maple is a good choice for a sunny wet site, what would we tell them? Are all ornamental pears equally susceptible to storm damage? What is the size of the species *Viburnum opulus* vs. the cultivar *Viburnum opulus* 'Compactum' vs. the cultivar *Viburnum opulus* 'Nanum'? Is it possible for chokeberries to get fireblight? These questions can all be answered with a good working understanding of how plants are named and classified.

Basics of Plant Classification

Plants, like all other organisms on earth, are classified in a hierarchical system, starting with the species and making it all the way up to one of the kingdoms of life. This system moves from related species in a genus to related genera in a family, on through order, class, subphylum, phylum, and kingdom. For practical horticulture, the most important of these classification units are the species, the genus, and the family. Thus *Pyrus calleryana* is the Latin name for the species known as Callery pear. *Pyrus calleryana* and *Pyrus communis* are different species in the genus *Pyrus*; and *Pyrus* (pears), *Malus* (apples and crabapples), *Aronia* (chokeberries), and *Rosa* (roses) are some of the genera in the rose family (the Rosaceae).

The most fundamental of these classification categories is the species. The idea of a species is sometimes hard to describe, often vaguely defined as "the basic unit of classification" or "plants of one kind." One of the most useful concepts of a species, however, relates to the fact that a species is a reproductively isolated population of organisms. This, too, is imperfect, of course, and respectable species like red maples and silver maples fail to read our books, and cross-fertilize anyway.

Nevertheless, even though we may not be able to always precisely define species, we often pretty much know one when we see it. Thus, human beings, gypsy moths, the fungus that causes apple scab disease, the dawn redwood, and the coast redwood are all seen as distinctly different species.

The Latin Binomial

In 1753, Linnaeus, a Swedish botanist, developed a system for naming a species with a two-part Latin name (the genus and the specific epithet). This Latin binomial for each species, is, believe it or not, a way to limit confusion. It helps us communicate with each other, even if we are in different countries speaking in different languages.

Michael Dirr points out the difficulties we would have with plant names if this system were not in place, using this example:

Nymphaea alba L., the European white waterlily, has:

- 15 common names in English.
- 44 common names in French.
- 105 common names in German.
- 81 common names in Dutch.

How would anyone in our global horticultural markets today communicate about a plant without Latin binomials — one name for one species — such as *Nymphaea alba* — instead of the 245 indicated above?

As to this botanical Latin — there are some rules. As you can see by the previous text, the plant name is *italicized* or <u>underlined</u> in text usages where italics are not available. The first letter of the genus name is capitalized; the first letter of the specific epithet is not. In scientific publications, but rarely elsewhere, the authority (person) that first described the plant is abbreviated after the Latin binomial (the "L." used in our earlier example is for Linnaeus, who is indicated by a single initial — a courtesy — sort of like calling Michael Jordan "Air").

So, to review, for some of the organisms we have discussed earlier, the Latin binomials for the species are:

Human beings — *Homo sapiens*

Apple scab fungus — *Venturia inaequalis*

Gypsy moth — *Lymantria dispar*

Dawn redwood — *Metasequoia glyptostroboides*

Coast redwood — *Sequoia sempervirens*

Red maple — *Acer rubrum*

Silver maple — *Acer saccharinum*

Notice that the last two examples were plants in the same genus (a group of related species). Also notice that each Latin binomial represents a species and is composed of the genus and the specific epithet.

Note: So what about the question previously asked about a red maple for an open, wet site?

Well, if a client asks you if a red maple is a good choice for a fairly wet, very sunny site, your answer depends on how well you and your customer understand the nuances of plant names. One answer could be that yes, red maples (*Acer rubrum*) are tailor-made for such a site.

On the other hand, what if the customer really means one of the red-leaved types of Japanese maple (*Acer palmatum)?* A sunny sight with less than good drainage could be a disaster for such a plant.

Further, the customer might mean by red maple one of the red-leaved types of Norway maple (*Acer platanoides*). Being aware of how names can mis-communicate is one of the responsibilities of a horticulturist to head off mis-understandings and mis-plantings.

Cultivars

There are, of course, other official names of plants in addition to the Latin binomial for the species, such as botanical varieties and subspecies, hybrid designations, patents, trademarks, and something very important to horticulturists — the cultivar.

Earlier in this century, the great plantsman Liberty Hyde Bailey coined the term cultivar for **culti**vated **var**iety. For woody plants, cultivars are trees and shrubs that are cloned, *e.g.*, asexually propagated (cuttings, grafts).

Here is an example of how cultivars are named. Some seedlings of the Norway maple, *Acer platanoides*, were seen to have reddish new growth and a wider spread — and were then cloned and sold as the cultivar *Acer platanoides* 'Schwedleri' and marketed as a Norway maple with these characteristics. Some seeds from this cultivar were also then planted out and one was noted to have season-long maroon-red leaves. This seemed to have great potential for the industry, so it was selected, cloned, and sold as the cultivar 'Crimson King.' The rest is history.

Note: Cultivar names are written with single quotes, and the first letters are capitalized: *Acer platanoides* 'Crimson King' or *Acer platanoides* cv. Crimson King.

Knowledge of different cultivars is critical to good communications and good horticulture. Here are a few examples.

Example No. 1

Not knowing about cultivars and how they differ can lead to over-generalizations about plants. In recent years, Bradford pears have received bad press because of their tendency to break in storms due to narrow crotch angles. Many street tree commissions, for example, have reacted by banning the use of all pears. This may be an example of throwing out the baby with the bath water, because most people do not know the nomenclature of the flowering pears.

Bradford pear is actually only one cultivar of the Callery pears in the genus *Pyrus.* It is:

Pyrus calleryana 'Bradford'

Many other Callery pears have less tight crotch angles and hold up better in storms than this cultivar. For example:

Pyrus calleryana 'Aristocrat'

Thinking that all the ornamental pears are Bradfords is a common mistake. Knowing the difference between cultivars is part of what makes you a knowledgeable horticulturist.

Example No. 2

How many of you have heard landscapers complain that they planted dwarf European cranberrybush viburnums that in a few years turned out to be four to five feet taller than desired? They complain about the nursery or garden center, not realizing that the problem stems from the plant they asked for or deliberately purchased. This is often due to a lack of awareness of the names of the plants involved. The species for European cranberrybush viburnum, which will grow to 12 feet or higher, is:

Viburnum opulus

The commonly planted cultivar that many people think is a dwarf is:

Viburnum opulus 'Compactum'

However, though it is smaller than the species, growing to maybe six feet, and is denser in its growing habit, it is not really a dwarf. For that you might plant:

Viburnum opulus 'Nanum'

which will grow to about two feet. Knowing what you need to request, buy, and plant is a big professional plus.

Plant Families

Plant families, as you will recall from previous text, are groups of related genera. Let's look at the very important rose family (Rosaceae), which includes such genera as:

Amelanchier — serviceberry

Aronia — chokecherry

Cotoneaster — cotoneaster

Crataegus — hawthorn

Malus — crabapple

Potentilla — potentilla or cinquefoil

Prunus — cherry, almond, plum

Pyracantha — firethorn

Pyrus — pear

Sorbus — mountainash

Rosa — rose

Spiraea — spiraea

If you think about the flowers of these genera (forget for a moment the amazing diversity of some of the cultivated roses and think instead of some of the shrub roses), you will note that they are very similar.

Think of how similar each crabapple flower is to a hawthorn flower or a Callery pear flower, or, for that matter, to individual mountainash florets. In fact, if you think of each floret of a mountainash flower and the fruits of a mountainash, it is easy to see that it is far more related to a spiraea or a firethorn than it is to any of the true ashes in the genus *Fraxinus*, which are in the Oleaceae family. It should come as no surprise that the reproductive parts of the plants, the fruits, seeds, and flowers, provide clues to the relatives of these plants.

It is easy to fool people on plant identification quizzes with the unusual rose-salmon fruits with bright orange seeds of *Euonymus europaeus*, but when you ask what roadside weed it looks related to, someone in the crowd always says American bittersweet (*Celastrus scandens*). Both *Celastrus* and *Euonymus*, indeed, are in the bittersweet family (Celastraceae).

This familial relationship can be used in many ways in practical horticulture. For example, the disease bacterial fireblight, caused by the bacterium *Erwinia amylovora*, occurs only on plants in the rose family, especially on *Pyracantha, Malus,* and *Pyrus* species. Symptoms of this disease include blighted shoots that are bent at the ends in the pattern of a shepherd's crook. This symptom can also be caused by other factors, though.

It is a great diagnostic aid, therefore, to be able to rule out fireblight, even if plants have crooked blighted shoots, if the plant is a maple (*Acer* spp.) or an ash (*Fraxinus* spp.), knowing that these plants are not in the Rosaceae family. Conversely, a good horticulturist would consider fireblight as a possibility if the plant is a mountainash (*Sorbus* spp.) or chokeberry (*Aronia* spp.), which are in the Rosaceae.

Another practical benefit of knowing plant families occurs when there are cultural requirements that cover most of the plants of a family. A classic case of this is with the heath family, the Ericaceae. Although members of the Ericaceae vary in their characterization as acid-loving plants, it is not a bad generalization to be concerned about planting ericaceous plants, such as azaleas and rhododendrons (*Rhododendron*), *Enkianthus, Pieris,* mountainlaurel (*Kalmia*), and blueberry (*Vaccinium*) in alkaline soils. Other horticultural practices limited by familial relationships occur, as well, from the likelihood of being able to make intergeneric crosses (difficult at best but more possible between genera in a family), to the likelihood of being able to graft a scion onto a rootstock (if from different genera, more likely between genera in the same family).

Some families contain only one genus, or even one species, such as *Cercidiphyllum japonicum* (katsuratree) in the Cercidiphyllaceae. More often than not, though, it is possible to note interesting similarities, for example, of fruits, between the multiple genera in a given plant family. For example, all of the trees in the nitrogen-fixing bean family (Fabaceae), including *Cercis* (redbud), *Cladrastis* (yellowwood), *Gleditsia* (honeylocust), *Gymnocladus* (Kentucky coffeetree), and *Laburnum* (goldenchaintree), have bean-like fruits.

The Fun of Latin Names

Finally, lets take a brief look at the fun of Latin names — many of which are derived from Greek roots. Here are a few examples:

1. *Philodendron* literally means "tree-lover," from the Greek *phileo* (to love) and *dendron* (a tree), referring to the vining nature of many *Philodendron* species.

2. Many genus names are derived from prominent people, such as *Gleditsia* (honeylocust) named for Gottlieb Gleditsch, *Hosta* for Nicolas Host, *Zinnia* for Johann Gottfried Zinn, *Nicotiana* (tobacco) named for the poor unfortunate Jean Nicot, and *Forsythia* named for William Forsyth. Now you know that Easterners are not being snooty when they say "for-sigh-thee-a" instead of "for-sith-ee-a!"

3. Latin names can also be quite beautiful and everyone has their favorites. How about these:

Liquidambar styraciflua (sweetgum) — the Latin literally means liquid amber, flowing with aromatic balsam.

Or how about *Liriodendron tulipifera* (tuliptree)? Feel how the sounds move trippingly off the tongue. And for literal-minded wildflower lovers there is *Orchis spectabilis* for the ethereally beautiful — showy orchis.

So, to come full circle, do you agree with the quote that started this article, or can you agree with Liberty Hyde Bailey, that:

"'What's in a name?' cries Juliet; 'that which we call a rose by any other word would smell as sweet.' Yet Shakespeare might admit that a rose is not less sweet because we know its name."

One final note:

Often arborists and other plant lovers fear that they may sound foolish if they mispronounce Latin binomials or stumble over spelling or taxonomic rules. Fear not.

First of all, remember that pronunciation of botanical Latin depends upon common usage, and you shall pick up on the local usage soon enough. Besides, some people say "to-may-to" and others say "to-mah-to." Such is life.

Secondly, we can do no better than to accept the advice of Linnaeus himself on this when he says:

"If you have remarked errors in me, your superior wisdom must pardon them. Who errs not when perambulating the domain of nature? Who can observe everything with accuracy? Correct me as a friend, and I as a friend will requite with kindness."

Note: This article has been adapted from articles by Jim Chatfield, Martin Quigley, and Ken Cochran in *Arborist News* and the Ohio Nursery and Landscape Association's Ohio Certified Nursery manuals.

References

Adams, D. (1996). *The Language of Horticulture.* Ohio State University Horticulture and Crop Science Department.

Bailey, L. H. (1976). *Hortus Third.* Macmillan Publishing Company.

Chatfield, J. and Cochran, K. (1997). The Naming of Plants. *Ohio Nursery and Landscape Association Ohio Certified Nursery Technician Manual*. Westerville, Ohio.

Combes, Allen J. (1995). *Dictionary of Plant Names.* Timber Press.

Cope, Edward A. (1986). Cultivar Nomenclature. *American Conifer Society Bulletin,* 4(1): 6-10.

Dirr, Michael A. (1998). *Manual of Woody Landscape Plants.* 5th Edition. Stipes Press.

Munson, Richard H. (1993). Trademarks: The End of Cultivars? *American Conifer Society Bulletin* 10(2): 76-79.

Stearn, William T. (1986). *Botanical Latin.* David & Charles Publishers.

Buckeye Blast: The October OSU Extension Nursery, Landscape, and Turf Team Tour

Amy K. Stone, Joseph F. Boggs, James A. Chatfield, Mary Maloney, Erik A. Draper, Hannah Mathers, Pamela J. Bennett, Jane C. Martin, and Marianne Riofrio

In 2001, the Extension Nursery, Landscape, and Turf Team (ENLTT) conducted four days of diverse educational programming, from October 1-4. A short summary of some of the programming, taken from the pages of the weekly (April-October) *Buckeye Yard and Garden Line,* follows.

Bluegrass BYGLive! — Lexington Kentucky

On October 1, 2001, ENLT Team members journeyed to Gainesway Horse Farm located just outside Lexington, Kentucky, to join Cincinnati BYGLive! participants for the Fourth Annual Bluegrass BYGLive! Our host, Larry Hanks (Pampered Properties Inc., Lexington), arranged for an outstanding program. Larry has been a long-time BYGLive! participant.

Amy K. Stone, Ohio State University Extension, Lucas County; Joseph F. Boggs, Ohio State University Extension, Hamilton County/Southwest District; James A. Chatfield, Ohio State University Extension, Northeast District/Horticulture and Crop Science; Mary Maloney, Chadwick Arboretum, The Ohio State University; Erik A. Draper, Ohio State University Extension, Geauga County; Hannah Mathers, Ohio State University Extension, Horticulture and Crop Science; Pamela J. Bennett, Ohio State University Extension, Clark County; Jane C. Martin, State University Extension, Franklin County; and Marianne Riofrio, Ohio State University Extension, Master Gardener Program.

A Winning Legacy

Participants were intrigued by research updates, courtesy of a cadre of Extension specialists and graduate students from the University of Kentucky. They were enthralled by a great mix of landscape challenges from the 2001 season, courtesy of Team members and Bluegrass BYGLive! participants. But, most of all, everyone was captivated by stunning vistas and beautiful Thoroughbred horses, courtesy of Gainesway Horse Farm.

Gainesway Horticulturist Ryan Martin gave a fascinating wagon tour of the Farm. Participants learned that Gainesway Horse Farm was founded by John Gaines, of Gaines Pet Food fame, in the early 70s. In 1988, the Farm was sold to the current owner, Graham J. Beck. The 1,500-acre farm has been and continues to be the home of an impressive collection of Thoroughbred contenders.

A majestic memorial water fountain that is lined with the names of notable horses honors this legacy. Several names on the memorial galloped through the collective memory of the participants, including Cannonade, winner of the 100th Kentucky Derby.

Of course, participants were also treated to seeing some of the current residents up close. Marion Gross, Stallion Manager, showed participants Broad Brush and

Cozzene, two of the Farm's top bread winners. Broad Brush was America's leading sire in 1994, and it currently costs more than $150,000 to secure his services. Last year, he became acquainted with 47 mares.

Cozzene was America's leading sire in 1996. While his charge is less ($60,000), he deals in volume. Last year, he was introduced to 84 mares. Bluegrass BYGLive! participants noticed a perceptible glint in his eyes.

The group moved from the awe-inspiring business end of the Thoroughbred horse industry to the cutting edge of turf and landscape research. Research updates from UK Extension Specialists and graduate students were provided by Dr. Bill Fountain, Horticulture; Dr. John Hartman, Plant Pathology; and Dr. Dan Potter, Entomology.

Ph.D. Research Pursuits

Graduate students in Dan's outstanding program highlighted their Ph.D. dissertation projects. The students included Jamee Hubbard, who is working to unlock the life cycle and management of calico scale; David Held, who is focusing on Japanese beetles to learn more about interactions with their hosts; and Michael Rogers, who is pursuing research on parasitoids of white grubs.

This group thoroughly impressed the participants with their lines of research and their results thus far. They clearly demonstrated why many believe UK has one of the top turf and landscape entomology programs in the nation.

Limestone, Karst, and Drought

Bill Fountain led a discussion on the effects of varying soil types on the water needs of landscape trees and shrubs. Bill noted that soil and rock strata conditions in the Lexington area provide some unique challenges. The underlying limestone rock strata produces what is known as a karst topography. The limestone caves and sinkholes that dot central Kentucky are among the most notable features of this type of topography.

However, a more subtle feature is the extremely rapid infiltration of water produced by the honeycombed nature of the limestone layers. Bill indicated that there is virtually no water table, and the karst topography tended to enhance the effects of even the smallest of droughts.

What Killed the Foals?

Dan Potter led a discussion regarding the on-going search for last season's widespread loss of Thoroughbred and other foals in Kentucky. The problem is now known as Mare Reproductive Loss Syndrome (MRLS) and was characterized by extremely high fetal mortality rates during the spring of 2001. The topic was particularly poignant and fitting given the location of the Bluegrass BYGLive! The economic impact of the foal deaths was estimated to exceed some $336 million through 2003, with more than $300 million of that centered in the Bluegrass region around Lexington. And the problem was not confined to Kentucky alone, but spread to neighboring states.

Early speculation focused on the possible role played by the extremely high populations of eastern tent caterpillar experienced this past spring in the Kentucky horse region. While the caterpillars feed on a wide range of hosts, cherry trees are preferred, and black cherry is very common in central Kentucky.

It was speculated that the caterpillars somehow served as a vehicle to carry the cyanogenic compounds contained in the cherry leaves to the horses. Observations that some symptoms appeared to be consistent with cyanide poisoning seemed to support this theory. Consequently, some horse farms have implemented a black cherry removal program. So far, Gainesway has not moved in this direction.

Dan noted that research conducted thus far by a colleague in the Department of Entomology indicates that it is highly unlikely the caterpillars delivered cyanide to the horses.

The caterpillars are apparently very good at detoxifying the cherry leaves, and virtually all the cyanide was removed in the caterpillars foregut. The compound was not found in the midgut, the hindgut, or the frass (excreta). It was also not incorporated into the body of the caterpillars. Although cyanide was present in the foregut, it was calculated that a horse would have to consume more than 2,000 lbs. of caterpillars in order to experience a toxic reaction.

The search for a causal agent is being pursued down several paths, but as with many puzzles encountered in nature, guideposts illuminated by solid scientific evidence remain elusive. Likewise, pitfalls have been impossible to avoid.

The entire story thus far provides a fascinating glimpse into the practical application of the scientific process. To the credit of UK, no final conclusions have been drawn, and the research continues.

A Scorching Devastation Hits Oak Trees

John Hartman conducted an information session on bacterial leaf scorch of oaks. The problem was of great interest to the group since it has been devastating to a number of oak species in central Kentucky, but it has yet to be found in Ohio. The impact was dramatic at Gainesway Farm as a large number of mature pin oaks had already been lost and more were infected.

The causal agent is a xylem-inhabiting bacterium *(Xylella fastidiosa)* that is thought to be transmitted from tree to tree by xylem-feeding insects such as leafhoppers *(e.g.,* sharpshooter leafhoppers) and treehoppers *(e.g.,* oak treehopper). However, since the disease spreads slowly from tree to tree, it is speculated that the insects are not very efficient vectors of the disease.

Bacterial leaf scorch has long been noted in the Atlantic and Gulf states, and it has spread inland to the Ohio River valley. The disease has been detected in Kentucky for a number of years and has recently been found in southern Indiana.

Ultimately, infected trees die from the disease, and John indicated that some Lexington neighborhoods have lost more than 70% of their mature red and pin oaks. While oaks remain the most dominant species affected in Kentucky, the disease has also been found on maples including red, silver, and sugar maple, as well as sycamore.

Symptoms vary somewhat between oak species. On pin oaks, scorching appears along the leaf margins and progresses inward toward the midvein. There is often a yellowish margin between the scorched leaf tissue and green tissue. On red oaks, the scorch typically appears at the leaf tip and progresses up the leaf towards the petiole. The overall pattern makes the leaves look like they had been dipped in chocolate.

The timing of leaf scorch symptoms can present a diagnostic challenge. Infected trees often show no leaf scorch in the spring and early to mid summer. Symptoms usually first appear as a few scorched leaves sometime in mid-to-late August, but the scorching expands rapidly to involve other leaves in September and October.

The challenge is that the symptoms can be easily mistaken for physiological leaf scorch or early fall color. However, since a number of other diseases, as well as cultural problems, can mimic bacterial leaf scorch symptoms, John strongly recommended that suspected infections be confirmed by sending samples to a diagnostic clinic before concluding the tree is infected with the bacterium.

There is no cure for bacterial leaf scorch, so one should expect diseased trees to be gradually lost over the years. The best remedy for bacterial leaf scorch is tree replacement. However, in the meantime, infected trees can be made to look somewhat presentable for a few more years if the dead wood is pruned out. Since little is known regarding which species of insects serve as vectors for the disease, or exactly how disease transmission occurs, there are no insecticide recommendations available for disease prevention.

35th Ohio Plant Diagnostic Workshop, Columbus, Ohio

On October 2, 2001, Buckeye Blast migrated northward for the semiannual Plant Diagnostic Workshop. With all due respect to past speakers at this Workshop, the formal speakers for this time around were the strongest ever. They included:

One of the World's Top Scientists on Ice Cores and Global Warming

Lonnie Thompson, an Ohio State University glaciologist recently recognized by *Time Magazine* as one of the top scientists in the world for his work on the "archive" of past atmospheric environments in ice cores dating back over 420,000 years, discussed his research. This work is a major piece in the understanding of global warming.

Looking at air trapped in the ice cores, Thompson and associates have demonstrated the ever-increasing rise in carbon dioxide rates in recent years. Until industrialization, increases in carbon dioxide levels followed a predictable pattern of variability in which levels oscillated, for example, between periods of glaciation and volcanic activity, but never in the history of the cores higher than 300 parts per million (ppm).

With increased industrialization and release of greenhouse gases through burning of fossil fuels in recent decades, carbon dioxide levels in 1958 were at 315 ppm and by this year are pushing 370 ppm, with projections approaching 600 ppm in the year 2060. With the relationship of atmospheric carbon dioxide levels to increased temperatures, this archival ice core data is a crucial piece of data in the case for significant and potentially devastating global warming in the coming century.

Dr. Thompson also spoke of the rapid disappearance of current mountain glaciers around the world, at increasingly faster rates than normal. He left us with two quotes from the father of glaciology, Louis Agassiz: "Study nature and not books" and "Strive to interpret what really exists."

Georgia's Diagnosis from a Distance

Dr. Julian Beckwith, program manager of the Distance Diagnostic program at the University of Georgia, spoke of the successes they have had in the past several years with this program. Distance Diagnostics links almost 100 Georgia county extension offices with their plant disease clinic.

Using a major grant from a foundation in Georgia, coupled with matching dollars from the state lottery, they used $1.2 million dollars to outfit these offices with a dedicated computer, a color digital camera, dissecting and compound microscopes, diagnostic resources and training, and a system linking these offices to the clinic and specialists at the University of Georgia at Athens for rapid turnaround diagnosis of problems.

About a quarter of the clinic's samples are now received digitally from these remote locations. Some of the great benefits they see from this program in Georgia include:

- High-profile rapid responses, such as identification of a poisonous plant resulting in immediate medical attention.
- Development of a system that now has many more trained diagnosticians, since county agents now use microscopes and prepare samples for photography.
- An economic impact that they estimate to be in excess of $17 million dollars in the past 18 months.

Their next step in development is a Land-Grant Digital Media Library of slides and other instructional materials from contributors.

And in Shorter Presentations...

Sudden Death of Oaks

Pierluigi (Enrico) Bonello, urban plant pathologist for Ohio State University, updated the group on the status of Sudden Oak Death Syndrome, a relatively new disease problem that is quite serious on tanoak and true oaks in California, caused by the fungus *Phytophthora ramorum.*

This fungus has been identified on rhododendrons from Germany and also now confirmed on oaks in Oregon, and is listed as a host of a number of plants, including California buckeye and other oaks including red oak and pin oak.

It causes large trunk cankers, is quite devastating, and has received a great deal of attention from the U.S. Department of Agriculture, which has approved $24 million in funding, including $19 million for research. Thankfully, it is not yet reported from the eastern United States.

To learn more about this disease, check out: **www.CNR.Berkeley.EDU/comtf/**

Soil Samples and Plant Diagnostics

Dr. Charles Darrah, owner of CLC labs (soil and tissue testing), highlighted a number of case studies illustrative of how soil sampling is often essential to plant problem diagnostics, especially relative to salt concentrations associated with road salts and with fertilizer irregularities.

Ask the Right Questions — Systematically

Dr. Robert Partyka, long-time Ohio plant pathologist and plant diagnostician, used additional case studies to illustrate how diagnosticians need to use the diagnostic process to systematically ask the right questions and look carefully at the evidence when doing a diagnosis, rather than relying on a few "usual suspects."

Plant diagnosticians are the Sherlock Holmes and Quincys of the horticultural world!

Sharing Outrageous Examples

Participants also shared samples in the Clinic Catharsis and Diagmoshtics sessions, including sycamore and hawthorn lace bug damage, outrageously spectacular euonymus scale infestations on European euonymus in which leaves were spotted and stems were entirely encrusted, and some unusual dawn redwood twigs in which there was a proliferation of buds on the end of some of the twigs.

36th Workshop Scheduled

Set your sights next on the 36th Ohio Plant Diagnostic Workshop. It will be June 6-7, 2002, and features a return to Stone Lab on Gibraltar Island in Lake Erie. The usual diagnostics, coupled with the ferry rides, an overnight stay at the Stone Lab dorms, diagmoshtics around the campfire and maybe even the stray rowboat ride around the island at midnight.

OSU/ONLA Research Day

For the third day of Buckeye Blast programming, Hannah Mathers organized a very successful OSU/ONLA Research Day on October 3 in Wooster at OSU's Ohio Agricultural Research and Development Center (OARDC). During the day a wide variety of OSU and USDA researchers/ extension faculty and industry affiliates gave short (15 minute) presentations on their research programs. At the end there was a time for input from the industry regarding research directions and suggestions.

This was a joint program between OSU/ Department of Horticulture and Crop Science, OSU Extension and ONLA. It was well attended by nursery personnel from various locations in the state and received an excellent response from the industry. Speakers included:

Hannah Mathers
OSU/Horticulture and Crop Science
Herbicide Treated Mulches for Ornamental Weed Control

Mike Klein
USDA/Entomology, OARDC/Wooster
Developing Quarantine Treatments for the Japanese Beetle

Robert Hansen
OSU/OARDC/Food, Agricultural, and Biological Engineering
Computer-Controlled Irrigation and Fertigation of Container-Grown Landscape Nursery Plants

Mike Reding
USDA/Entomology, OARDC/Wooster
Insect Research Review 2001 and a Look into The Future

Harry Hoitink
OSU/OARDC/Plant Pathology
Biological Control of Plant Diseases with Composts and Microbial Inoculants Through Systemic Induced Resistance

Joe Kovach
OSU/ Entomology
Dan Herms
OSU/ Entomology
Multicolored Asian Lady Beetles: When Good Beetles Go Bad

Pierluigi (Enrico) Bonello
OSU /Plant Pathology
Tree Health Research at Ohio State University

Dan Herms
OSU/Entomology
Entomology Program Review

Mimi Rose
TruGreen ChemLawn
Are We Applying Fertilizer When It Is Efficiently Used by the Plant?

Nancy Taylor
OSU/ Plant Pathology
Plant and Pest Diagnostic Clinic Overview

Susan Jones
OSU/ Entomology
Household and Structural Insect Pests Associated with Landscape Plantings

Randy Zondag
OSU Extension/Lake County
Program Overview and IR-4 Update

Jim Chatfield
OSU/ Extension/NE District and Horticulture and Crop Science
OSU Crabapple Disease Evaluation Trials

Joanne Kick-Raack
OSU/ Extension/Pesticide Education Program
New Legislation Proposed for Ohio Commercial Applicators

Charles Krause
USDA/ARS, Wooster
OSU/OARDC Electron Microscope Lab

Eric Draper
OSU/Extension/Geauga County
National Crabapple Evaluation Trials

at Secrest Arboretum

Ken Cochran
OSU/OARDC/Secrest Arboretum
Secrest Arboretum Research Tours

A variety of indoor presentations took place during the morning, and there were some outdoor presentations and a tour of facilities and experiments during the afternoon. The industry input session in the afternoon was very helpful in terms of hearing the concerns of the industry and some research areas that need further attention.

The objective of the day was to update industry personnel about all the great research going on in Ohio, explain our current research projects, and receive industry feedback. The target audience was professional nursery growers, professional landscapers, and professional industry affiliates.

Judging by the feedback and attending audience, we were very successful in accomplishing our goals, and an annual OSU/ONLA Research Day is in the future; for 2002 it will be held in Columbus.

Master Gardener Diagnostic Workshop

On the final day of Buckeye Blast, Oct. 4, 2001, ENLTTers met at the OSU Extension Clark County office where more than 40 OSU Master Gardener volunteers were treated to a diagnostic workshop. The teaching team included Joe Boggs, Jim Chatfield, Erik Draper, Amy Stone, Jane Martin, Marianne Riofrio, Gary Gao, and Pam Bennett.

This hands-on learning opportunity provided the volunteers with four hours of advanced training credit. The state requires that MG volunteers complete six hours of advanced training each year. Volunteers came from numerous counties across the state and enjoyed a day of learning and camaraderie.

Participants in the workshop also toured the Gateway Learning Gardens located at the Clark County Extension office. They saw the results of the Herbaceous Ornamental Field Trials, various demonstration gardens, as well as the new children's demonstration garden.

BYGLOSOPHY

The team tour was a great success. Team members always enjoy getting out into the state; it's always a reminder to see what's going on outside of our every day paths.

Team members also have a very strong position regarding keeping in touch with the industry and the volunteers that they serve. Rudyard Kipling sums it up best with the following: "He who only England knows, knows England least."

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